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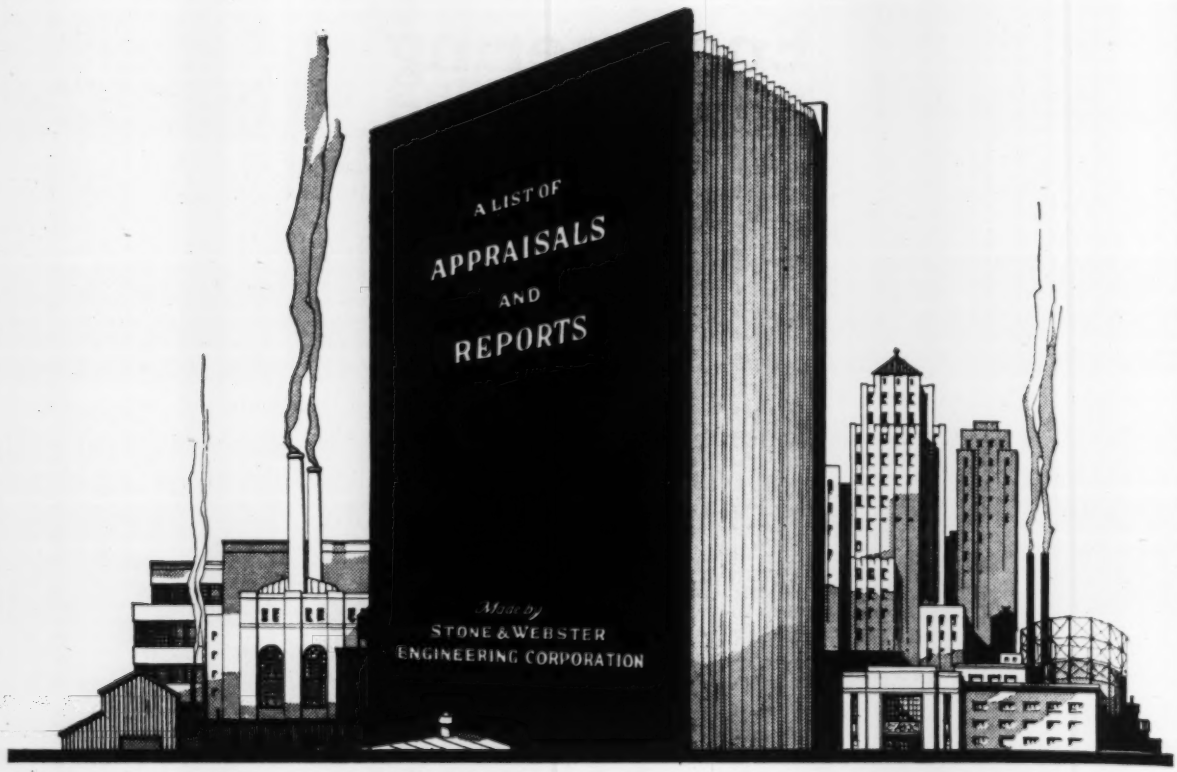

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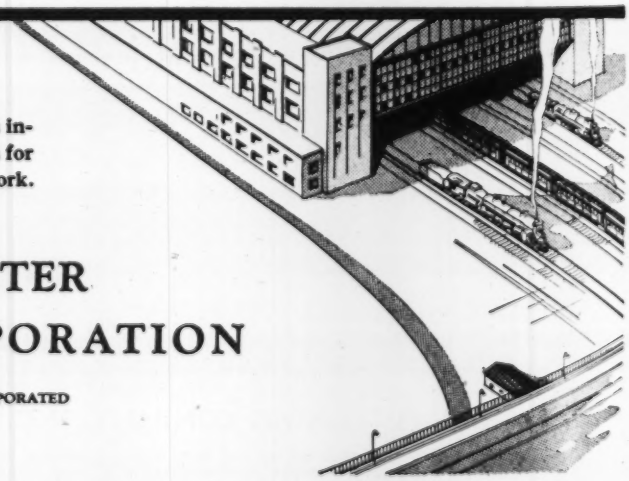

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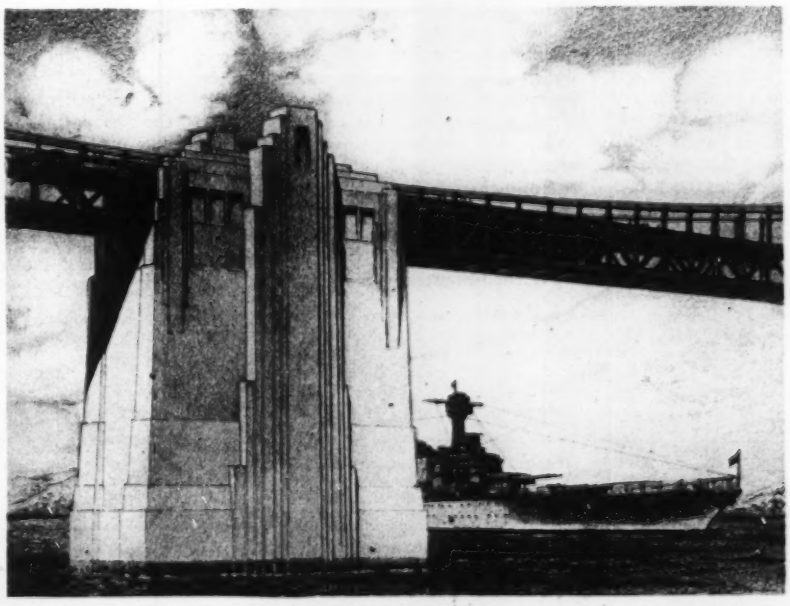
The San Francisco-Oakland Bay Bridge

Construction of great bridge to start at once with R.F.C. financing—Enterprise includes two 2,310-ft. suspension spans, a 500-ft. island tunnel and a 1,400-ft. cantilever —History of project and structural features outlined

CONSTRUCTION work on the $75,000,000 bridge across San Francisco Bay, connecting the city of San Francisco with the metropolitan area on the east side of the bay, will be started soon as a result of Reconstruction Finance Corporation financing announced recently. Plans and specification are ready for calling bids on both west and east channel piers, and this initial work will begin a 3½-year construction program estimated to employ about 6,000 men directly and give work to as many more by reason of indirect operations.

The toll project includes approaches, two 2,310-ft. suspension spans (with central anchorage) in the west channel, a 500-ft. tunnel through Yerba Buena Island and a 1,400-ft. cantilever span across the east channel, aggregating a total length of 7½ miles. Double-deck construction will provide for vehicular and rapid-transit traffic. The structure will be owned and operated by the state, and conservative estimates provide for amortization in 25 years at tolls that will be less than present ferry rates. At the end of that period the bridge will become a free structure with maintenance assumed by the state.



Central anchorage for suspension spans has plan dimensions of 97x192 ft. and will be founded on rock 180 ft. below low water.

The bridge will span the 5-mile water barrier between the city of San Francisco and the group of municipalities constituting the metropolitan area on the east side of the bay. The combined population of the communities thus connected is about 1,250,000. At the present time transportation facilities are provided by ferries for both vehicular and passenger traffic. Alignment of the bridge necessitates a tunnel through Yerba Buena (Goat) Island, dividing the structure into an east and west channel crossing. The west channel crossing between San Francisco and the island will consist of two twin 2,310-ft. suspension spans with 1,160-ft. side spans, totaling about 9,000 ft. The supporting structures include four main towers, a center common anchorage and the shore and island anchorages.

The hill on the island will be pierced by a tunnel 500 ft. long. From the tunnel

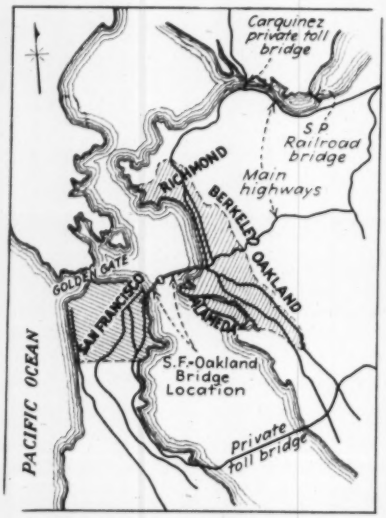
a short viaduct will extend over the remainder of the island to the 1,400-ft. cantilever span across the main east channel, followed by five 509-ft. fixed spans of through trusses and fourteen 291-ft. truss spans to the end of a fill north of the existing rapid-transit fill. An artist's sketch, superimposed on a photograph of the bridge, is reproduced at the bottom of this and the succeeding page.

The San Francisco terminal will be reached by an elevated structure from the harbor line to a location near the intersection of Fifth and Howard Sts. From this point, which is centrally located as regards population and traffic, traffic distribution will be made by the present street system. Ramps will also be provided to bring the upper-deck traffic to grade nearer the business district of San Francisco. To disperse the traffic, the terminal for the lower deck will be at still another point. The interurban terminal will be on Minna St. between Fremont and Second Sts.

The proposed bridge crossing from San Francisco to Oakland has been actively discussed for at least 25 years. It remained for the comparatively recent development of vehicular traffic to bring the project within the realm of economic feasibiliy. Ferries have operated between San Francisco and the east side of the bay since 1851, but only since the introduction of the automobile has the volume of traffic become significant. During 1920 the one automobile ferry system operating across the bay handled 773,000 vehicles, and in 1930 the three ferry systems handled 4,544,000 vehicles an increase in the decade of about 500 per cent. In addition to this vehicular traffic, 35,000,000 people (principally commuters) are ferried across the bay annually. Obviously such traffic increase and volume would lead to the serious consideration of a structure to eliminate the attendant inconvenience and loss of time. Additional considerations, including the inconvenience to shipping, delay in fogs, with attendant possibility of danger, and the extension of the commuting radius, were factors involved. It is estimated that the bridge will reduce the average time for vehicular crossing by about 30 min. and provide a corresponding saving in time for passenger traffic.

The past interest in this project is indicated by the fact that there have been 37 applications either by individuals or corporations to the local authorities for a permit to provide a bay crossing. All of these applications were rejected on the theory that it was to the public interest that such an important structure be publicly owned and operated.

Following a comprehensive report made by the state highway commission on privately owned toll bridges in the state (*ENR*, April 11, 1929, p. 606), the 1929 session of the legislature passed an important series of bills providing for state ownership of all toll



San Francisco metropolitan area, with principal traffic arteries that will be tied together by the new bridge.

bridges by construction or purchase. These laws (*ENR*, June 27, 1929, p. 1,048) established the California Toll Bridge Authority (governor, lieutenant governor, director of the department of public works, director of finance and chairman of the state highway commission) and provided for the financing of construction cost or purchase price by revenue bonds to be retired by tolls. The validity of the revenue bond measure was subsequently upheld by the state supreme court.

Following this fundamental progress in establishing a definite policy for ownership and control of the proposed bridge, the next step was to determine with definiteness the economic and structural feasibility and an acceptable location. Realizing that both local and national interests were involved, a joint commission was appointed by President Hoover and Governor Young; representatives of both the army and the navy were on this board. This commission rendered a report Aug. 6, 1930, finding the project to be necessary for the development of the area and structurally and financially feasible. The board also recommended the general location and alignment of the structure as finally adopted.

The 1931 legislative session passed a group of bills providing: (1) a $50,000 loan from state funds for preliminary work; (2) adoption of the proposed bridge as part of the state highway system, which provides for the maintenance of the structure; and (3) amendments to the toll bridge authority act to make revenue bonds more salable (*ENR*, Aug. 6, 1931, p. 227). C. H. Purcell, state highway engineer, was named chief engineer for the authority, an office was opened in San Francisco, and design studies and extensive foundation exploration work were started.

Subsequently a consulting board was appointed consisting of Ralph Modjeski, chairman, Moran & Proctor, L. S. Moisseiff, Charles Derleth, Jr., and H. J. Brunnier. This board has held several extended sessions, studying general plans for the project and details of foundations and superstructure design. Plans have been approved by this consulting board, and the report of the engineering staff presented to the R.F.C. was approved by the advisory board of that body.

Approval of various features by the interested national authorities has been secured, including congressional authority for crossing Yerba Buena Island, which is owned by the government, and acceptance of the general and detail plans by the war department.

Traffic and revenue

Comprehensive studies were made for the preparation of traffic estimates. These figures have been compared with

Bay Bridge, connecting San Francisco (at the left) with Oakland, includes two 2,310-ft. suspension spans over the west channel and a 1,400-ft. cantilever span and numerous truss spans over the east channel. On the island will be a double-deck tunnel 80x60 ft. (From an artist's sketch.)

similar estimates made for existing structures and then checked against the actual records of these structures. All possible factors tending to influence future traffic have been taken into consideration, and it is considered that the figures on which the amortization has been based are ultra-conservative. No attempt has been made to introduce a factor based on the stimulation resulting from the establishing of a bridge crossing.

Some points on the curve of actual and estimated annual vehicular traffic follow:

1915	364,000
1930	4,500,000
1937	8,000,000
1943	10,000,000
1950	12,600,000

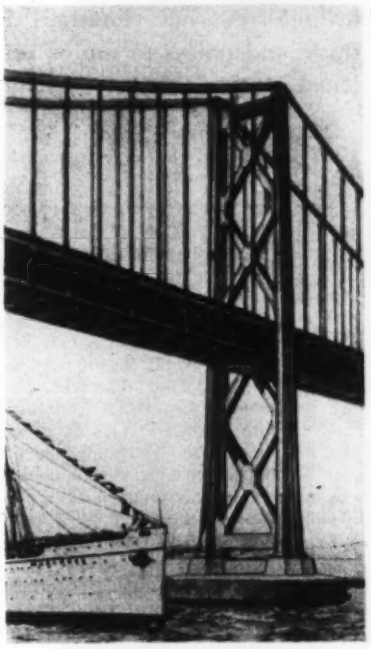
These figures assume that ferry service will not be continued.

For the purpose of estimating revenue the toll per car has been fixed at 50c. for the first years, with a predicted decrease to 40c. during the later years of the financing. The present ferry fare is 60c. per car. It is estimated that even though the ferry facilities were maintained, the matter of convenience and lower rate would assure about 80 per cent of the total traffic. This is in accord with records on existing structures. The interurban passenger traffic now being carried across the bay amounts to about 35,000,000 people annually. For estimating purposes this traffic has been assumed to produce a revenue of 1c. per passenger per crossing.

These traffic and revenue studies indicate that on a conservative estimate the capitalized cost of $75,000,000 for the structure can be amortized within a 25-year period at an interest rate of 5 per cent. The cost estimate includes the San Francisco approach and terminal structures required to place both vehicular and passenger traffic on street elevation in San Francisco. At the Oakland end of the bridge the structure reaches ground elevation near the edge of the bay because of the long fill; the highway approach facilities from this point will be provided by the various communities in conjunction with the state highway commission.

Structural features

Beginning at the western terminal of the structure, the major structural features are outlined in order. East of the San Francisco terminal and viaduct approach the first feature of importance is the San Francisco anchorage for the first suspension span. This gravity anchorage is founded on rock at the surface of the ground, about 1,000 ft. back from the San Francisco harbor line. The next foundation structure is the first water pier (No. 2), which will be founded on rock by open cofferdam construction and will support the structural-steel tower for the suspension span. The next pier (No. 3) will be the deepest of the foundation structures, being founded on rock at an estimated depth of 218 ft. below low water. This pier, in common with the central anchorage and the other two piers in the west channel crossing, will rest on a cellular concrete and steel caisson (75x127 ft.) sunk by the open dredging method.



Suspension span towers are 460 ft. high and provide a 214-ft. shipping clearance for the double-deck roadway. Towers and piers are designed for earthquake forces of 7½ per cent of gravity.

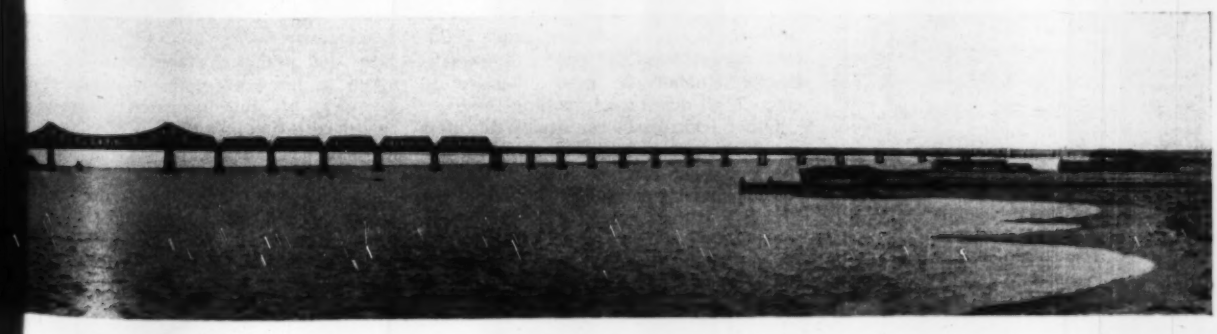
At pier 3 the water depth is about 40 ft., and the underlying strata of mud, sand and clay form a relatively homogeneous material; it is believed that no particular difficulties will be encountered in the sinking process. All piers in the west channel crossing will be founded on sandstone rock, and foundations are designed to carry the combined loads of the structure, including wind, tide and also stresses caused by earthquake shock, equaling 7½ per cent of gravity acceleration. The structural-steel towers resting upon these piers will be 460 ft. high and will provide a clearance of 214 ft. above high water for the deck.

The next foundation structure in the west channel will be the common central anchorage of the two long suspension spans, which is designed to take care of live cable loads, the dead loads being balanced. This will be the largest caisson, its dimensions to be 97x192 ft. in plan. It will be founded on rock at a depth of 180 ft. below low water. A sketch of this proposed anchorage is shown in the accompanying illustration. The next two piers (Nos. 5 and 6) will be similar in construction to pier 3 and will be founded on rock by open dredging. The depth to rock for these piers will be less, although the water will be deeper, with a maximum water depth of about 110 ft. for pier 6. The anchorage on the island will be a combined tunnel and gravity design set deep in sandstone formation.

On these substructures will be built two twin suspension spans having 2,310-ft. central spans and balanced side spans of 1,160 ft. The design of these suspension spans was made by the deflection theory, and the design and stress calculations were checked by elaborate model tests (*ENR*, June 9, 1932, p. 828). The suspension spans do not involve any outstanding design feature, although they are exceeded in length only by the Hudson River bridge at New York.

Vertical clearances provided in the west channel crossing are 176 ft. above high water at the San Francisco harbor line, increasing to 214 ft. at the first pier. This clearance of 214 ft. is maintained across the west channel crossing to pier 6.

Design studies indicate that the piers do not need fenders for stability. As a result the timber fenders will be directly connected to the piers to provide cushioning against damage from ship-



ping. These timber fenders have been approved by the war department and shipping interests. Double-deck design provides for an upper level carrying six fast lanes of vehicular traffic on a 58-ft. roadway and a lower level providing three lanes of heavy truck traffic and two interurban tracks. All of the superstructure design includes provision for resisting earthquake stresses induced by a horizontal acceleration of 7½ per cent of gravity.

From the west channel crossing the traffic will enter an approach cut and then pass through a 500-ft. tunnel under the summit of Yerba Buena Island. This tunnel will provide the same double-deck width of roadway as the bridge proper and will be unique principally in the size of cross-section, 80x60 ft. The tunnel will be driven through sandstone and lined with concrete. No ventilation system will be provided because of the short length and the prevailing wind.

East of the island tunnel the structure will continue on viaduct construction to the 1,400-ft. main cantilever span across the east navigation channel. This span will include two 511-ft. anchor arms. Foundations for the piers in the east channel crossing are more difficult because the foundation rock dips sharply on the east side of the island. The first pier will be sunk to rock foundation, and the next piers under the major spans will be sunk into a foundation consisting of a consolidated gravel conglomerate. The foundations farther east will rest on pile foundations to the beginning of the fill. Beyond the east anchor arm of the main cantilever the superstructure will consist of five fixed spans 509 ft. long to the Oakland harbor line and will continue with fourteen 291-ft. fixed spans to the beginning of the fill. The vertical clearance across the major east channel crossing of the cantilever will be 185 ft. above high water.

Principal quantities of construction materials involved in the project are: 170,000 tons of structural steel and wire, 20,000 tons of reinforcing steel, 200,000 gal. of paint, 40,000,000 b.ft. of lumber, 1,000,000 bbl. of cement, 1,000,000 cu.yd. of aggregates (approximate).

Under the present proposed plan to get the work started by November the man-hours of work to be provided by this project are estimated as follows during the first few months:

	Man-Hours
November	300,000
December	400,000
January	600,000
February	1,000,000
March	1,000,000
April	1,200,000

The structure is being built by the California Toll Bridge Authority, James Rolph, Jr., governor, and Col. Walter E. Garrison, director of public works. C. H. Purcell is chief engineer, C. E. Andrew is bridge engineer, and Glenn B. Woodruff is engineer of design.

Improved Riding Qualities for Street Cars

Experimental study traces noise and excessive weight to high-frequency vibrations due to rigid wheels and track, and points to use of resilient wheels and cushioned trucks—Smooth acceleration promotes comfort

ELABORATE research work in progress on the shortcomings of present types of street cars and on means of avoiding these shortcomings promises to lead to development of quieter and easier riding cars, according to information given by C. F. Hirshfeld, engineer in charge of the work, in an address to the American Transit Association at Chicago on Sept. 28. The work was begun eighteen months ago for the Electric Railway Presidents' Conference Committee. Study of the characteristics of present cars has been completed, and current work is concerned with development of new elements of car construction. The following notes are based on a report in *Transit Journal*, October, 1932.

Street-car noise is due mainly to the rigid wheels now used, the research demonstrated. The interaction of rigid wheel and track gives rise to severe impacts that transmit high-frequency vibrations to the trucks and body of the car. Accelerometer tests showed very high impacts at the journal boxes and progressively decreasing impacts farther up in the structure. These impacts also govern the size and weight of the car parts.

Resilient wheels were proved to reduce these high-frequency vibrations and to cause correspondingly less noise. As wheels of this type have been found unsatisfactory in practice, tests were carried out upon various old and new designs of wheels in a machine that permitted impact and noise intensities to be measured. They showed that a satisfactory resilient car wheel can be developed, and that by its use the impacts can be so reduced as to permit of radical improvements in truck design.

Based on this conclusion, new forms of trucks have been designed, at least one of which "appears to meet the various requirements, such as light weight, sufficient strength, low and simple maintenance, quietness and good riding qualities." Rubber is used liberally to cushion all driving and rolling forces.

Other features of car design and performance studied in the research include the factors of car motion in relation to the passenger's comfort. At present the greatest rate of acceleration of cars in service approaches 3 miles per hour per second, and this rate is recognized as being at the limit of possibility in respect to passenger discomfort and slipping wheels. Experiments made by getting the reactions of passengers standing on a moving platform under various accelerations indicated that smoothness of acceleration is of first importance to riding comfort. With smooth acceleration, also, a higher total acceleration can be built up rather rapidly. But the length of time during which the passenger is subjected to a high acceleration is a factor in discomfort.

To obtain smooth acceleration it will be necessary to provide new forms of control equipment. Development work in this direction is in progress by manufacturers. While compound-wound motors, running constantly and driving the car through variable-speed transmissions, are considered the ideal means, the present work is proceeding on the view that such transmissions will not become available.

In further experiments on riding comfort the test subjects were placed in a seat fastened to a platform so supported that it could be vibrated with any desired amplitude and any desired frequency, up and down, fore and aft, transversely, or in a composite of two or three directions. Preliminary study of the results indicates that the threshold values depend on the direction of vibration, and that there is some connection between this relation and the way in which the human body has been developed to resist the motions recurring in walking and running. The range of amplitudes and frequencies tolerable with comfort is rather narrow. Most street-car trucks are so sprung as to fall within or close to the zone of comfort with respect to vertical motion, but they seem to fall well outside the comfortable range in other respects.

With similar test equipment, stresses in car bodies were measured. Data were thus obtained for the design of a lighter integrated type of body. The development work already done indicates that practical manufacture can be taken in hand promptly when the remainder of the program warrants. Standardization of parts is possible to an extent assuring economy without limiting flexibility of application.

Smoother braking, better lighting and effective ventilation are among the other subjects of study included in the research and development program. Better brake equipment has already been designed.

Development of Low-Heat Cement for Mass Concrete

Size of modern concrete dams and construction speed intensify problems of cracking—Present cements generate high heat during hydration—Modification of chemical composition retards and reduces heat rise

By R. W. Carlson
Research Engineer, Engineering Materials Laboratory, University of California

APPRECIATION of real effects of hydration heat in mass concrete, with subsequent cooling and contraction, has been relatively recent, but study of the problem has been prompt and aggressive. The attack has centered in the field of cement chemistry, and progress has been comparatively rapid in the fundamental plan to cut the quantity of heat at the source—the hydrating cement. Engineers interested in the field of concrete dam construction should not fail to keep in touch with these developments. In the following article the subject is reviewed as to history and recent developments with an explanation of the chemistry involved which is pleasingly understandable to the engineer. The author is actively engaged in the program of cement investigation for Hoover Dam and is in touch with the latest developments in this particular field. For a subject that will be of increasing interest and importance in the realm of dam construction, the present article is a valuable preface. —EDITOR.

INCREASE in the size of mass-concrete structures, acceleration of construction speed and the increased activity of present-day portland cement have focused the attention of cement chemists and engineers on the growing problem of reducing and possibly eliminating cracks in large concrete masses. Although a single line of attack will not solve the entire problem, present indications point to the development and use of a cement of modified characteristics—similar in its essentials to the cement of the 1890's—as most promising in decreasing the amount of heat generated during the period of hardening, thereby reducing the amount of expansion and subsequent contraction.

The problem

In the relatively thin sections employed in most concrete work, volume changes other than those due to stress are caused principally by variation in moisture content; the heat generated by chemical action during hydration of the cement is not a factor because it is dissipated rapidly. In mass structures, however, the interior of the concrete dries very slowly, if at all, and the principal volume changes are caused by the variations in temperature that accompany the liberation of heat by the hydrating cement and the dissipation of this heat from the concrete. Thus the problem of correcting the tendency of a large mass of concrete to crack resolves itself into reducing the effects of the heat of hydration of the cement.

In considering the possibility of decreasing heat generation the other properties of the concrete must not be neglected. The following conditions are desirable for mass-concrete construction:

1. Small temperature changes during the periods of active cement hydration and subseuent cooling.
2. Sufficient early strength to permit economical removal of forms.
3. Adequate ultimate strength for design requirements.
4. Small volume change caused by moisture variation, to reduce the tendency toward cracking at and near exposed surfaces.
5. Reasonable degree of durability, or weather resistance.
6. Low permeability, to prevent measurable percolation of water.

Proper balance of these conditions must also take into account the cost of manufacturing and placing the concrete.

In the following discussion of heat generation the other five properties enumerated are considered but not necessarily discussed in detail. Obviously, if nothing more were desired in a cement than low-heat generation, it would be possible to manufacture a cement having extremely low chemical activity, but this cement would most probably be lacking in strength, volume constancy and durability.

Temperature rise in concrete, with its undesirable effects, can be reduced either by (*a*) using less cement per cubic yard of concrete, (*b*) placing the concrete slowly, so that much of the heat will be dissipated to the atmosphere, or (*c*) using a cement that has the characteristic of low-heat generation. With present methods of placement, material reduction of the cement content is impracticable from considerations of workability, permeability and durability. Slow placement is uneconomical and apparently out of the question in modern construction. The development of a cement that liberates but little heat during hydration, however, is decidedly promising.

TABLE I—COMPARISON OF CHARACTERISTICS OF MAJOR CEMENT COMPOUNDS

	Tricalcium Silicate	Dicalcium Silicate	Tricalcium Aluminate	Tetracalcium Alumino-Ferrite
Cementing value..	Good	Good	Poor	Poor
Rate of reaction..	Medium	Slow	Fast	Slow
Amount of heat liberated.....	Medium	Small	Large	Small

Compounds in portland cement

Portland cement consists essentially of four major compounds—tricalcium silicate, dicalcium silicate, tricalcium aluminate and tetracalcium alumino-ferrite—with various minor compounds that are not of importance here. (Bogue, R. H., "Calculation of Compounds in Portland Cement," Analytical Edition, *Industrial and Engineering Chemistry*, Oct. 15, 1929.) A partial classification of the important characteristics of these major compounds is given by Table 1.

The calcium silicates are the effective cementing materials, while the other compounds are generally believed to have little or no cementing value. All of these compounds liberate heat during hydration, and the total amount of heat liberated is, in general, proportional to the rate of chemical reaction. Tricalcium aluminate hydrates most rapidly, chiefly within the first day. Tricalcium silicate hydrates less rapidly, chiefly within the first week. Dicalcium silicate hydrates very slowly, chiefly after the first week. Tetracalcium aluminoferrite hydrates slowly, and since it is considered to have no great cementing value it is believed to be of minor importance. Considering all properties of cement, including volume constancy and durability, tricalcium aluminate is believed to be the least desirable of the four major compounds.

Early vs. present cements

It is interesting to compare the composition of the typical cement used in construction of dams in the 1890's with that of the typical portland cement of today. The approximate major compounds, fineness, strength and heat generation values are listed in Table II. It is evident that the early cements contained a high percentage of dicalcium silicate, with its slow development of strength (and heat). It was customary to grind these cements to a fineness of only about

TABLE II — COMPARISON OF EARLY, PRESENT-DAY AND MASS-CONCRETE CEMENTS

Cement	Tricalcium Silicate, Per Cent	Dicalcium Silicate, Per Cent	Tricalcium Aluminate, Per Cent	Fineness, Pass 200-Mesh, Per Cent	28-Day Strength of 1:3 Mortar, Lb. Per Sq. In.	28-Day Heat Generation, Cal. Per Gram Cement
Probable average of 1890.....	31	36	18	80	1,500	90
Typical standard portland (1932).	55	23	11	90	4,000	100
Pine Canyon dam (1932).....	30	46	5	92	2,500[1]	75[2]

[1] Expected average; specified minimum is 2,000 lb. per sq.in.
[2] Expected average; specified maximum is 80 cal. per gram.

80 per cent passing the 200-mesh sieve, to reduce grinding costs and to prevent "quick set." The high percentage of tricalcium aluminate probably contributed to the early activity in these cements, but the heat liberated during the first few days was satisfactorily dissipated because of the slow rate of concrete placement, which was an important factor in the results obtained.

Cement of about the composition given was used in 1887-1890 in the construction of the Crystal Springs dam near San Francisco (*ENR*, May 8, 1930, p. 766), and the excellent condition of the structure today attests the suitability of the cement for the conditions under which it was used. Other dams built several decades ago appear to be in better condition as regards cracking and weather resistance than are some recent structures.

The typical standard portland cement of today contains more than 50 per cent of the fairly fast-reacting compound, tricalcium silicate, and is ground to a fineness of about 90 per cent passing a 200-mesh sieve. Compared with the old cements, this cement hardens more rapidly and has higher heat generation at all ages. When it is used in large masses, the concrete becomes rigid while temperatures are still considerably above normal, and the inevitable result in the subsequent cooling is the formation of so-called shrinkage cracks. Placing of fresh lifts of concrete in rapid succession tends to entrap the heat and to aggravate the condition.

It must not be assumed, however, that cements of the type used in early days could be used successfully today without modification. Much of their potential strength was wasted because lack of sufficient grinding failed to produce the large number of particles necessary to bind the aggregates of the concrete together efficiently. Yet the cement expert of today would not recommend finer grinding of the formerly used compositions because of their high tricalcium-aluminate content. Present equipment and technique of blending and burning have made it possible to reduce the tricalcium aluminate to about one-half of its former percentage, and the tendency seems to be to reduce it still further.

To summarize, the cements of early days had two good features for mass-concrete construction—low tricalcium-silicate content and high dicalcium-silicate content—and two undesirable features—high tricalcium-aluminate content and coarse grinding.

Mass makes the problem

During the recent construction of a Western dam, considerable cracking was observed in the buttresses, which were 5 ft. thick. Standard portland cement was being used, and this was changed to a coarser grind to reduce the rate of temperature change without affecting the chemical characteristics or seriously reducing the ultimate strength. Since the section of concrete was relatively thin, dissipation of heat from the surfaces was comparatively rapid, so that the temperature rise was governed only by the *rate* of heat liberation during the first three days, the total heat of hydration being relatively unimportant. Appreciable reduction in temperature rise resulted.

In another structure of larger mass, however, resort to the same remedy failed to produce the desired results. The rapid placing of lifts and the extreme thickness of section did not permit the escape of heat in sufficient quantities to prevent a high rise in temperature and consequently some internal cracking. In this case the governing factor was the *total* amount of heat liberated rather than the rate at early ages.

Interground silica cement

One early development in cements for mass construction was the blending of fine siliceous material with cement, primarily as a measure of economy and not with the idea of reducing temperature rise. Quantities of silica up to 50 per cent were interground with the cement used in the construction of several structures, including the Arrowrock and Elephant Butte dams built by the U. S. Reclamation Service. Records indicate that the temperature rise in the Arrowrock Dam was substantially lower than would have occurred if regular portland cement had been used. The ultimate strength of the concrete was satisfactorily high, indicating that the siliceous material had cementing value. In some instances low durability of the surface concrete has been observed, but in all cases under observation the interior concrete is sound and hard.

Some interest is at present being displayed in the development of interground silica cements as a promising means of reducing temperature rise, since adequate strengths can be obtained with material reduction in heat generation. However, the factors bearing on the use of such cements where durability and low shrinkage upon drying are important have not yet been determined.

Present trends

As a result of recent research on the properties of a cement suitable for mass-concrete construction, specifications were prepared for bids on two types of low-heat cements for the Pine Canyon dam, now under construction by Pasadena, Calif. (*ENR*, Oct. 6, 1932, p. 411). The U. S. Bureau of Reclamation is carrying on an exhaustive study of the same general subject in the engineering materials laboratory of the University of California in connection with cement research for the Hoover Dam. It is expected that this investigation will make possible the selection of a cement having desirable properties for mass concrete without material departure from the field of time-tried compositions. Also, notable work in the field of low-heat cements has been done by the Riverside Cement Co., Riverside, Calif., including the development and application of the heat-of-solution method for measuring the heat generation to the field of cement chemistry. (Hubert Woods and H. H. Steinour, "The Heat Evolved by Cement During Hardening," *ENR*, Oct. 6, 1932, p. 404).

The present trend apparently is toward the selection of a cement somewhat similar to the product of early days, but with many of the objectionable properties removed. Cement for the Pine Canyon dam, which may be regarded as an example, is compared with the typical standard portland cement of 1932 in Table II. It is seen that the mass-concrete cement has less tricalcium silicate, more dicalcium silicate and a minimum percentage of the troublesome compound, tricalcium aluminate. Incidentally, such a cement would not necessarily be suitable for general concrete work because of its characteristics of slow hardening.

The most striking departure in the new cement is the reduction in content of tricalcium aluminate. Some authorities feel that this should be further reduced to 3 or even 2 per cent. With commercially available raw materials, it is difficult to reduce the tricalcium aluminate to these figures, and cement of such a composition would be rather expensive to burn and grind. An iron compound is usually added to the raw materials to combine with the alumina present so that the alumina will not be available for producing the tricalcium-aluminute compound.

The other major difference between the mass-concrete cement and the typical portland lies in the relative percentages of the two silicates. Here again the compound which contributes high-early strength (tricalcium silicate) is substantially reduced in the low-heat cement. Slow hardening, however, is not undesirable in mass-concrete construction; it is in fact an advantage, since the entire concrete mass comprising sections cast at different times expands and contracts more nearly as a unit. Satisfactory ultimate strength is assured by the relatively high percentage of dicalcium silicate, whose hydration occurs chiefly after the first week.

These changes in chemical composition obviously minimize the most serious problems of temperature rise and resulting stress in mass concrete by reducing the temperature rise about 25 per cent. Since a certain degree of heating and cooling may be withstood by the concrete without residual tension, the reduction from the upper limit has a relatively large effect. The changes in chemical composition also permit fine grinding of the cement, giving the advantage of increased workability, strength and watertightness.

Definite progress has undoubtedly

been made in studying this most pressing subject in the field of mass-concrete construction, although much remains to be learned. The problem is being approached from the standpoint of fundamentals. The final answer has not been written as yet, but it is already believed to be possible to prepare a better specification for mass-concrete cement than has been done before.

Macadam Road Built With Bituminized Cement

Construction procedure on 2,700-ft. section of state-aid highway in Massachusetts—Mortar binding placed between two courses of stone

THE FIRST major installation in this country of the new bituminized-cement macadam road, developed in Germany, has just been completed at Hampden, Mass., by the use of methods in wide variance with American highway practice. A 2,700-ft. section of state-aid road, 20 ft. wide, was built by sandwiching a layer of special cement mortar between two courses of large crushed stone and rolling the whole into a homogeneous mass. The result is an unusually dense pavement, weighing about 170 lb. per cu.ft., capable of carrying heavy traffic immediately after final rolling. Tests made in Germany indicate that this type of pavement is waterproof and does not crack under temperature stresses, a property imparted by the special cement and considered so important that the product has been named T.R.C. (temperature-resisting cement).

American and European experiments with bituminized-cement roads were outlined in two articles published in *ENR*, Oct. 6, 1932, p. 400. The first installation for actual highway service in this country was made in September at Great Barrington, Mass., where 1,700 ft. of new road and 500 ft. of surfacing were placed.

The impregnation of portland cement with bitumen gives it several peculiar properties, including greatly retarded setting, increased workability and ability to repel excess water. It is not known definitely as yet just what chemical action takes place in the hydration of the cement. A grout, mortar or concrete made with it will continue to throw off excess clear water, free from cement or bitumen particles, until apparently just enough water is retained for perfect hydration. A time of 96 days is required to reach a final set comparable with the 28-day set of normal cement. Mortar made with bituminized cement is slightly darker and "fatter" in appearance than straight cement mortar, but the dark color is said to bleach out eventually.

Fig. 1—Spreading the mortar binding on bituminized-cement bound macadam road, Hampden, Mass.

Fig. 2—Laying of top stone course follows close behind spreading of mortar. Lightly rolled bottom layer of coarse stone is shown at left.

Construction procedure

The Hampden road job was a town work-relief project; therefore a maximum of local hand labor was used. The road was designated as Massachusetts Chapter 90, a secondary type, with a 12-in. gravel-sand sub-base. The contractor doing the work estimated the surfacing to cost between $1.10 and $1.15 per yard after the subgrade was prepared. This included, however, the addition of fine crushed rock to the sandy subgrade, which otherwise would have worked up into the base course, preventing thorough penetration of mortar.

Because of the necessity of keeping the road open to traffic during construction the macadam was placed in two 10-ft. strips, though the subgrade was prepared full width. A delay in keeping the subgrade ahead of surfacing operations made it necessary one day to go back and work on the second half of the road, thereby throwing all traffic, including 5-ton stone trucks and transit mixers, over the strip placed the day before. This procedure demonstrated the stability of the macadam when completed.

The first operation in laying the macadam was to spread a 2½-in. layer of large stone over the subgrade. This

Fig. 3—A seal coat of mortar is broomed into the final rolled surface to bind the top stones. Appearance of surface after thorough rolling of second course of large stone can be seen at right. Note how mortar has worked to the surface but not over it.

stone was all one size, passing a 2½-in. ring and retained on a 1¾-in. ring. It was sound trap rock, desirably free from flats, hauled from a quarry at Westfield 20 miles away. A heavy roller was passed over this bottom course a few times to provide a fairly smooth surface for the application of the mortar.

Next a layer of 1:2½ special cement and sand mortar was spread over the lower stone course to a depth of 1½ in. The mortar was batched at Springfield, 10 miles away, and hauled to the job in 3-yd. transit mixers, being mixed en route with 6 gal. of water per bag of cement. This amount of water made the mortar the right consistency for spreading. Extra water for thinning the mortar for the seal coat was carried by the mixer trucks. The mortar was transferred to the road by a chute and was spread by hand with the use of wooden scrapers.

Immediately after the mortar was spread, a second course of stone, identical with the first in thickness and size of stone, was applied by hand-spreading. A 12-ton three-wheeled roller then went to work on the macadam, rolling it continuously until the mortar worked up to, but not over, the surface. This rolling compacted the mass into the desired final thickness of 4 in.

The next operation was to seal the surface with thin mortar brushed into place with steel brooms. This procedure assured complete binding of the top stones. Despite vigorous brooming, very few stones were displaced. After the seal coat had dried out sufficiently to prevent picking up, a light tandem roller was used to compact the seal mortar into possible voids surrounding the top stones.

Final treatment consisted of brushing another layer of thin mortar over the surface, on which was spread a coat of stone dust and chips, lightly rolled. This formed a temporary wearing surface for the protection of the top stones in the macadam until they were fully set. The chips and dust wear off in about two weeks under normal traffic. The surface of the macadam, because of the presence of large stones, offers an ideal non-skid face, and yet is smooth in riding qualities.

The placing of the lower stone, mortar and upper course and the subsequent rolling are continuous operations. The seal and wearing coats are carried forward about three times daily. The resulting pavement is strictly a cement-bound macadam, with one-size stone used throughout, as distinguished from graded aggregate concrete. It is interesting to note that a continued hard rainfall did not halt the construction operations.

Fig. 4—Slushing a coat of thin mortar over the seal coat to hold a temporary wearing surface of stone dust and chips.

Fig. 5—Although both courses of large stone were spread by hand, the macadam is remarkably smooth and uniform in thickness after a thorough rolling. The final coat of stone dust and chips has been applied here. The straight edge is secured by means of timber guide forms.

Engineers and contractors

The Hampden project was built under the direction of L. O. Howlett, supervisor of roads for the town. Fred T. Ley & Co., Inc., Springfield, Mass., acted as contractor. The firm of Pearson Hall, Inc., is the distributor of T.R.C. cement and promotes this type of macadam road in New England. This firm was recently formed as a separate company by T. A. Pearson and W. J. Ferguson, vice-presidents of Fred T. Ley & Co., Inc. M. J. Collins was superintendent for the Fred T. Ley Co. The bituminized cement is being manufactured in this country by the Medusa Portland Cement Co., Cleveland, at its York, Pa., plant. Manufacture is being carried out under special license.

Water Levels in Wells in Northern Virginia

The drought conditions that have recently existed in northern Virginia have attracted attention to the records of water levels that are being obtained in five observation wells in Arlington and Fairfax counties, near Washington, D. C., through the cooperation of the United States Geological Survey and the Virginia Geological Survey. Four of these wells are equipped with automatic water-stage recorders, and the other is measured weekly. One of them has been equipped with an automatic recorder since July, 1928; two others have been under observation since the summer of 1931.

Pronounced rise in the water levels in the winter of 1931-32 and especially in the spring of 1932 shows that during this period there was abundant replenishment of the groundwater supply, apparently overcoming the exceptional depletion caused by the severe drought of 1930. Since about June 1, however, there has been a general and rather large decline in the water levels, showing that there has been little or no recharge during the present summer. Because of the dry condition of the soil there will be no further recharge until considerable rain has fallen, and there will probably be further lowering of the water levels this fall. However, in all three of the wells that have been under observation in the last two years the water levels were considerably higher on Sept. 1, 1932, than on the same date in 1931. With respect to groundwater storage the present situation is therefore favorable as compared with the situation in 1931, as well as that in 1930.

Telescopic Traveling Mast to Land Lakehurst Dirigibles

Ship can be moored 160 ft. above ground and be moved into shed against 40-mile wind

A LONG ADVANCE over the mobile mooring truck or "mast" of fixed height built for the Akron airship plant a year ago is represented by a traveling mast of telescoping construction just installed at the Lakehurst air station of the U. S. Navy by its designer and builder, the Wellman Engineering Co., of Cleveland. As against the 76-ft. mooring height of the Akron machine (*ENR*, July 23, 1931, p. 146), that at Lakehurst can moor a ship at maximum height of 160 ft. above ground or minimum height (fully telescoped) of 75 ft. In tests it was able to withstand side pulls of 1,000 lb. at full height and 60,000 lb. when telescoped, and to exert a drawbar pull of 57,000 lb.

In arrangement it is a structural-steel pyramid with square base 80 ft. on a side, carried on four four-wheel standard-gage trucks running on railway tracks, capable of traveling around curves by virtue of automatic electric compensation of the truck driving motors. The telescoping tower, extending up through the apex of the pyramid, consists of two sections moving in roller-bearing guide rollers mounted in pairs in adjustable equalizers, and raised by rope-hoist mechanism so reeved that the two sections extend or telescope simultaneously. The tower is built of alloy steel, to give greatest strength against the pull of the ship for given weight. At its top is the inverted conical bell to receive the mooring cone carried in the airship's nose. This cup can rotate in a spindle and a grimbal ring and has a resilient mounting.

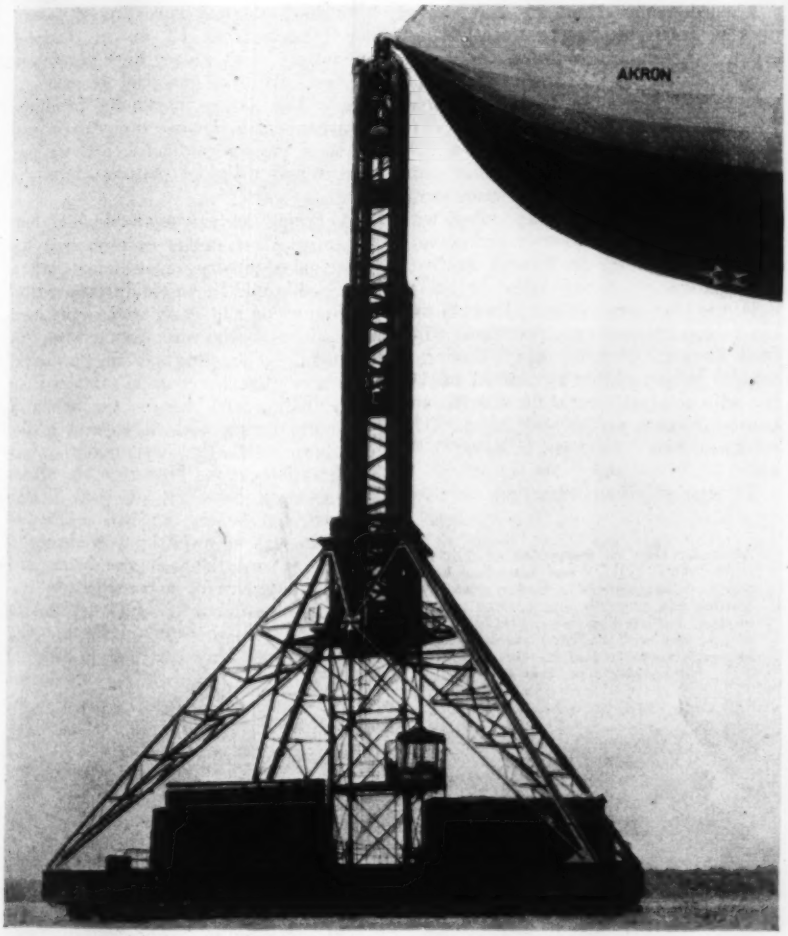


Fig. 1—Lakehurst traveling mooring mast extended to full height of 160 ft.; the base platform, 80 ft. square, is supported on four special railway trucks.

Power for all motors, lighting and control is generated by an eight-cylinder gasoline engine, which with its auxiliaries is contained in a house on one side of the machine deck. The hoist

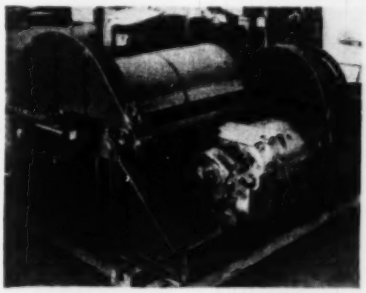


Fig. 2—The large hoist unit required for raising and lowering the mast; base and housings are welded from steel plates.

by which the telescoping tower is raised and lowered, together with the mooring winch, is housed on the opposite side of the deck. A glass-inclosed pilot house for the operator is attached to the side of the tower.

When a ship is to be moored to the mast, a line secured to the ship and passing through the pendant "cone" on the ship's bow, and carrying a special coupling device on its end, is dropped to the ground. Previously the free end of a similar line on the mast, leading from the mooring winch up through the center of the telescopic mast sections and out at the top of the cup, has been lowered to the ground. The two line ends are quickly connected, and the line is made taut by hauling in on the mooring winch. A further operation of the winch in the same direction pulls the ship downward and toward the mast until the cone is firmly seated in the cup and locked in position. To aid in steadying the ship during this operation, yaw winches located outside, and independent of the mast, manipulate other lines attached to the ship.

After the bow of the ship is secured to its anchorage, docking is assisted by a traveling stern-towing car known as a "stern beam," serving to hold the ship's stern lines while trailing the mast and moored ship in the low telescoped position from the mooring circle to the hangar, or vice-versa. The mooring mast is designed to travel during that trip around track curves, ascending a 3 per cent grade against a 40-mile-per-hour wind, at speeds ranging from creeping to 2 miles per hour. If necessary, however, air brakes on the mast trucks can lock the entire mast with airship against the specified wind pressure; electrical sanding of the driving wheels makes the braking secure.

Beach Drainage Safeguards Alexander Dam

Reconstruction of Hawaiian dam which failed in 1930 during construction completed safely by installing a system of drains in the downstream beach section

By Joel B. Cox
Engineer, McBryde Sugar Co., Eleele, Kauai, Hawaii

THE STORY of the Alexander Dam may be taken as an example of the close interdependence of the art and the science of engineering. It is in the development of the science of soil mechanics and its application to the art of earth-dam building that the greatest importance of the work must lie. The interest to engineers is in three aspects:

First is the fact that the entire history of hydraulic-fill dam construction points to the need of more exact knowledge of construction processes and hazards and hence of technical control. It is in the development of possibilities for a rational design of such structures that the importance of this work most strongly lies.

Second, and intimately connected with this question of design, is the fact that the accident at the Alexander Dam was due to an unrecognized hazard—one which had never been described or analyzed and hence was unlikely to be guarded against adequately. This was the danger of a beach rendered impermeable by crushing.

Third is the successful method employed to overcome this difficulty—the installation of a drainage system within the beaches. This is a new resource for dam designers and may render available dam sites that have hitherto been considered impracticable because of unsuitable material.

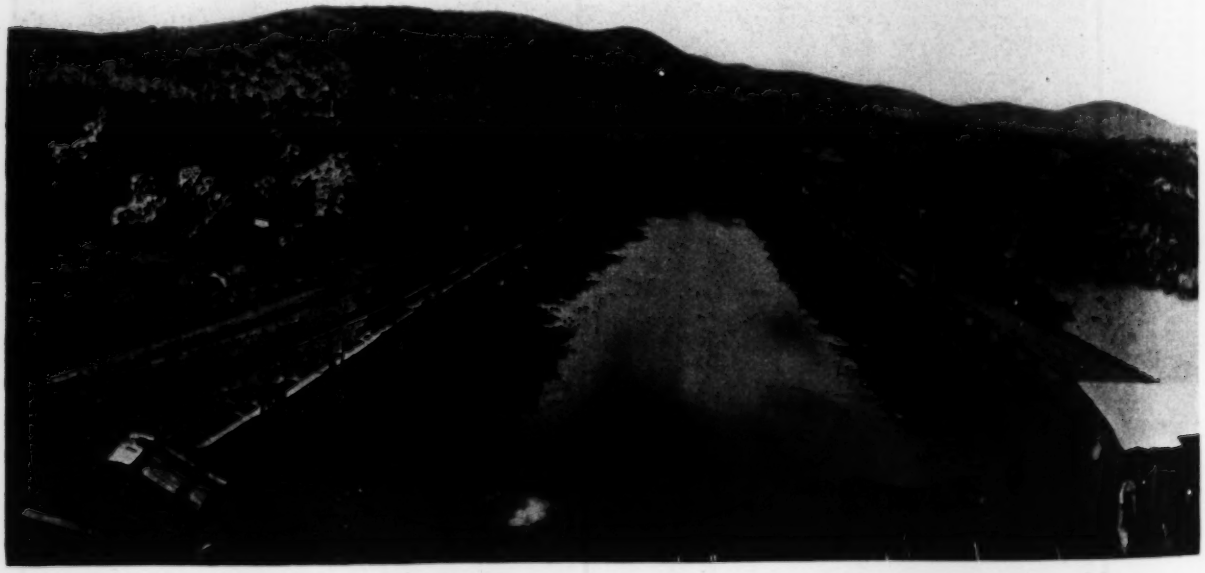
Original dam

The Alexander Dam was constructed by the McBryde Sugar Co., Ltd., to create a reservoir extending the water-supply system of the McBryde Plantation in the Hawaiian Island of Kauai. The dam is at an elevation of 1485 ft. The water shed has an area of 2.64 square miles, over which the mean rainfall is 180 in. a year. The dam spans a natural contraction in the valley, with ridges fitting the adopted section very neatly. A careful study was made of the relationship between the height of dam, the cost (including spillways) and the value of the storage produced. The final design called for a fill having a central height above streambed of 140 ft., with a crest length of 620 ft., and a total volume of 540,000 cu.yd. The reservoir has a capacity of 810,000,000 gal.

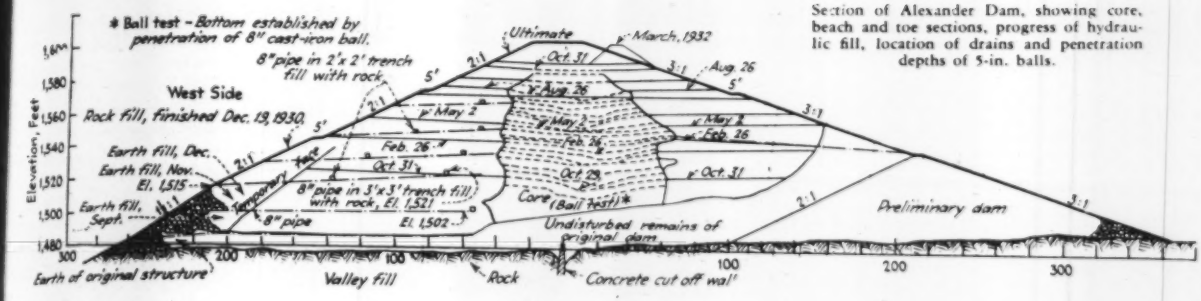
To expedite the utilization of water for irrigation on the plantation and for the power plant dependent on reservoir storage at this site, the heel of the dam was built first to a height of 50 ft. Construction of this initial section was begun in August, 1928, and was completed in January, 1929. Sluicing on the remaining section of the dam began in May, 1929.

From the beginning it was recognized that difficult problems were presented by the only material available near the site. This is a laterite, clay-like in character, the disintegrated product of lava and volcanic ash. There are no definite hard grains of any considerable size, and continued agitation with water will reduce the grain size to any desired degree. The process of excavation and sluicing, therefore, delivers at the dam a mass of material consisting of decomposed rock from 12 in. in diameter downward, with a very high percentage of fine, clay-like material of colloidal size. The large fragments form the upstream and downstream beach sections of the hydraulic fill, and the fine grains and colloidal material form the core.

A review of the available literature led to the erroneous opinion that the principal difficulty in utilizing such a material would be to obtain proper consolidation of the core, and a program of soil research was directed to this problem. The progress of the work, laboratory tests, recovered samples from core drilling and, finally, the action of the core during and subsequent to the slip show that the core material was quite satisfactory. However, on March 26, 1930, a blow-out or slide in the downstream beach or shell section of the dam was followed by a discharge of the core pool through the break and the washing out of a considerable section of the dam. A full account of this slide will be found in *Engineering News-Record* May 22, 1930, p. 869.



Alexander Dam on completion of sluicing in November, 1931. Wood flume from borrowpit, where material is broken down by blasting and hydraulic giants, forks at end of dam, and one branch parallels each side of core pool with discharge outlets at close intervals; flumes 24 x 24 in. with steel-plate bottom have 3 per cent grade.



Section of Alexander Dam, showing core, beach and toe sections, progress of hydraulic fill, location of drains and penetration depths of 5-in. balls.

The traditional explanation of somewhat similar movements, ascribing them to excessive pressures from unconsolidated cores, was untenable. The tests on the clay within the core, both before and after the slide, showed greater consolidation than had been computed. The clay core remained standing within the dam to a height of 30 ft. above the level to which the beach section was eroded by the escaping core pool. The initial failure within the beach zone was restricted to an area 30 ft. high and 60 ft. wide, which would not be the case in a general beach movement caused by pressures as far back as the core itself. The core pool was watched at the time of the slide by several observers and was undisturbed and showed no change in level during the movement of the blow-out until the collapse of the beach allowed the pool to overflow at the top.

The movement of reference points on the slopes of the dam had been slowing down and finally had ceased a short time before the blow-out, contrary to experience with dams in which the core pressures were obviously excessive, in which such movements were great and accelerating near the danger point. Finally a series of tests of the beach materials allowed a complete explanation of the collapse. The fragments of decomposed rock forming this section of the dam were found to have high crushing strength when dry or moist but to be very weak when saturated. When mechanically crushed they produced a mass, a large portion of which was of colloidal size, very fluid and highly impermeable.

It was found that the immediate cause of the collapse was the local compacting of the downstream beach section due to crushing of the fragments composing it. As a result, the permeability was rapidly reduced, allowing the accumulation of hydrostatic head that finally blew out and precipitated the slides.

Reconstruction plan

A study of the failure and its causes and the available means of remedy resulted in a decision to rebuild along substantially the same lines as the original construction but to overcome the intrinsic difficulties of the poor beach material by: (1) the maximum feasible increase in beach section, (2) the building of a rockfill toe 40 ft. high, (3) the artificial drainage of the downstream beach section by tile drains and rockfilled trenches. The first two resorts rendered only a small degree of additional security; the last is the important element in the reconstruction.

Drainage system

While a number of successful systems have been installed at ground level to drain the bases of earthfill dams, no precedents were found for drainage at higher levels, and no information was available on the design or the probable action of such drains. It was known that the most serious menace to successful action was disruption by movements and readjustments within the earth mass as the pressure therein increased. These movements reach large proportions and would tend to displace tile drains and interrupt their service. Four features of the design were counted on to minimize the danger of such interruption of service:

(1) Each drain was laid in a comparatively large rockfilled trench, 24x18 in. for the smallest 3-in. tile up to 48x36 in. for the very effective drains parallel to the dam axis carrying 8-in. tile.

(2) Near the core in the softer material, the feeder drains of 3-in. tile were laid with old light railroad rails inside them. The tile was strung on the rails like beads on a string in the hope that the steel would serve to prevent loss of alignment and a closure of the water passages.

(3) At each drainage level the drainage channels were laid out on a grid-iron system with intersection channels both parallel and perpendicular to the dam axis, so that interruption to flow at any one point would not deprive the surrounding space of drainage.

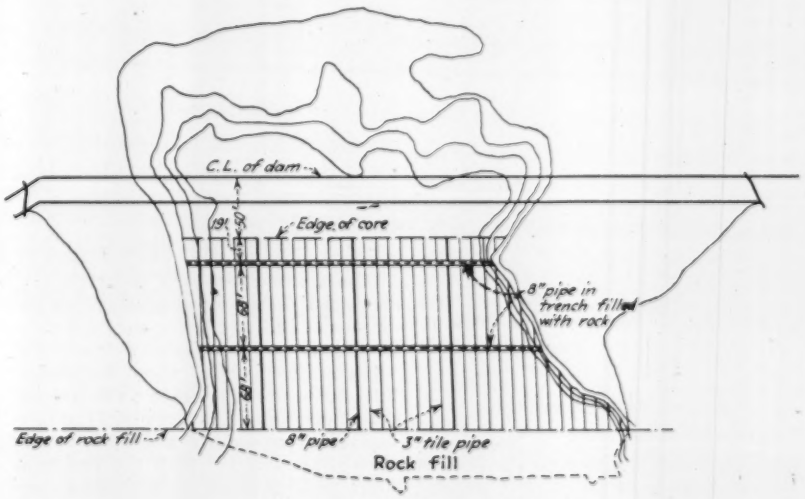
(4) The drains were laid on a steep grade so that internal settlement would not reverse the slope.

The drainage levels were installed at 1490-ft. elevation near the base of the dam and at 1500 ft., 1515 ft., 1530 ft., 1545 ft., and 1565 ft. on the downstream side. As the 3-in. tiles were spaced 10 ft. on centers and staggered in successive levels, this meant that no portion of the downstream beach (below the 1550-ft. level) was more than 8.33 ft. from a drainage channel. One drainage system at the top of the 50-ft. dam (El. 1545 ft.) was provided in the upstream beach.

Performance of drains

The records of drain outflows and of water table heights in the corresponding

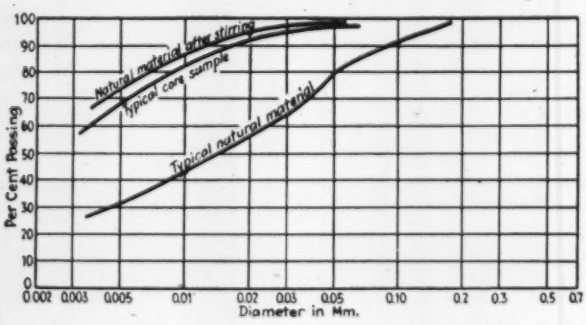
Plan of dam showing location of system of drains in downstream beach; drain location is further indicated in dam cross-section; system included 562 ft. of trench, 1027 ft. of 8-in. concrete pipe and 4331 ft. of 3-in. tile.



test wells are the best evidence of the effectiveness of this drainage system. The main collection at any time was at the base of the dam and from the highest drainage system. Intermediate systems collected a much smaller amount. The response to a cessation of sluicing operations was prompt in the upper levels, slow lower down. Apparently the lag due to a height of 100 ft. was approximately three weeks. As the dam increased in height and the area of beach decreased, the total outflow decreased at about the same rate. As the dam increased in height and pressures increased, the permeability of the material surrounding the drains decreased, so that though less water was to be handled, the head required remained nearly constant, only a moderate decrease in head being observable.

A check on the permeability of the surrounding material and a comparison of its value with that derived from laboratory tests of the same material was attempted by pumping or bailing from the test wells, observing the drawdown and inflow and computing the corresponding coefficient of permeability. While the large number of assumptions necessary as to extent of water table, radius of circle of influence, etc., makes such results inconclusive, they are interesting and show that when proper allowance is made for the great variability of the material their average checks well with that of the laboratory tests.

Mechanical analysis of material available for hydraulic fill of Alexander Dam.



The flow from individual drains and the variation in water table in individual wells indicate that interruption of flow in several parts of the dam did occur, but that the gridiron system prevented it from creating any serious pressure. The greatest head at any time was 6 ft. at a point near where the new fill joined that remaining from the first construction. Differential settlements in this vicinity were very much in evidence and probably caused the disruption of two of the local drains.

Rolled fill impracticable

Both the engineer and owners recognized from the inception of the project that the material available was not one from which a hydraulic-fill dam of normal cross-section could be constructed, as judged by the current criteria of fineness of grain and the empirical rules developed therefrom. The size of grain in the Alexander Dam borrowpits is shown in an accompanying diagram. No experience with strictly similar material for so large a dam was available, and hence application of the empirical knowledge of the profession was to a large extent uncertain.

To most engineers with experience of other types of earth, the obvious solution of the difficulty of construction by hydraulic methods would be to build a rolled-fill dam. This possibility received the most careful consideration in the case of the Alexander Dam, both at the beginning of construction and after the accident. Its rejection was based on experience with other rolled-fill dams in Hawaii, which have shown difficulty in compacting and a most appalling record of failures, due to the formation of water channels through the dam after completion. The fine structure and high voids of these soils, (about three times the volume of the solid matter when most thoroughly compacted) mean that unless puddled they contain large quantities of air very closely held. The result is a highly elastic mass that resists compacting and consolidates very unevenly under rolling.

The essential difference between the rolled-fill and the hydraulic-fill dam, under such conditions, is that the danger of failure of the rolled-fill dam is with full reservoir after completion, while the hydraulic fill presents a hazard only during construction. After it is finished its strength increases daily. It has already been subjected during construction to stresses many times those to which it will be subjected in service.

The hydraulic fill was completed at a cost (for fill alone), including all expenses due to the accident, of 29.03c. per cubic yard. The lowest possible estimate of the cost of a rolled-fill dam under the conditions at the site is very much greater.

Experimental control

The construction was undertaken in the belief that modern advances in the science of soil mechanics were sufficient to provide a framework of theoretical analysis that would allow laboratory tests to serve as a guide to the action of hitherto untried materials. The core had been so studied, and it had performed even better than the computations had predicted. This partial success led to the determination to develop a somewhat similar method of experimental study and control for the beach material.

The theory of clay consolidation, which is fundamental to any consideration of hydraulic-fill dam statics, dates from the work of Charles Terzaghi. Terzaghi's theory, with the resulting differential equations for the flow of water during compression and the resulting consolidation, produces an equation for the particular case of a hydraulic-fill dam core during the construction period, for which no exact method of integration is known. Recourse was therefore had to a process of finite approximate integration.

The dam cross-section was divided into a number of squares, and the flow of water from square to square during definite intervals of time was computed. It was found by trial that the method produced reasonably accurate results with only a comparatively small number of squares and hence, while laborious, it was feasible. A further simplification was later found in two empirical equations which summarized the results of a large number of such consolidation computations for triangular dam cores. The results of such consolidation computations were checked by field tests.

From the results of such consolidation studies the outward pressure of the core was computed when tests had shown the relationship between moisture content, pressure, shearing resistance and lateral pressure of the core material. The weight of the beach, its shearing resistance under various pressures and hydraulic conditions within it also proved capable of experimental study and checking against its behavior in the dam. The result of the computation enabled the following comparison with field experience.

Dam	Value of C. Volume Coefficient of Consolidation	Core Pressure, Per Cent of Liquid	Resulting Coef. of Shear in Beach
Germantown.....	.0183	99.6	0.57
Calaveras Upstream.....	.0279	98	0.537
Calaveras Downstream...	.0279	98	0.327
Alexander.....	.08 and .160	78.5	0.444

The Germantown dam, built with hard firm gravel in its banks, was undoubtedly safe at the friction factor stated. The upstream section of the Calaveras dam, built with material obtainable in a serpentine country, failed with much the same shearing coefficient. The downstream section with a lower shear stood.

Field checks

In addition to the series of samples obtained from borrowpits, beaches and core, both near the surface and deep down in the body of the dam, a comprehensive series of checks, measure-

ments, and observations was obtained day by day.

The first was a careful and systematic following up of the discharge from the various drainage outlets. Each of these was measured twice a week, and various summaries were plotted to show at a glance the variations in this flow that occurred with time, weather and working conditions.

A companion series of measurements was direct observation of the water table within the downstream beach area. At 30 points 2½-in. pipes with perforated strainer sections 6 ft. long were driven to the desired place in the fill and then carried up to the surface of the fill by 2-in. extensions. The 2-in. pipe was added as the dam rose, so that the top of the test-well casing was always a few feet above the soil level. The tops of these wells were suitably numbered for reference and kept tightly plugged except when opened up for observation. Each observation consisted of a sounding measuring the elevation of the water table by means of its mark on a chalked tape sunk by a suitable bob.

Movements of the exterior of the banks were continuously observed by transit and tape measurements and by levels run to a series of reference points embedded in the earth or rock of the dam slopes. These points were placed 15 ft. apart vertically and about 70 ft. horizontally, covering both upstream and downstream slopes.

The rate of settlement of the upper surface of the fill was followed by means of posts across the dam on which levels were obtained every few days. As one set of posts was buried, another set replaced it.

In addition to these regular measurements, a record was kept of movements of the flumes which rested on the fill, and it was easily possible to infer fill movements therefrom.

In July, 1931, a test well was sunk 37 ft. east of the center line, and partially consolidated core samples were obtained at various depths.

Of the many men who contributed to the success of this undertaking, only a few can be mentioned here. John Waterhouse, the president of the McBryde Sugar Co., and Frank Alexander, its manager, for whom the dam has been named, are first in influence and in the importance of their contributions. The writer has been the engineer throughout the design and construction, with J. H. Foss as consulting engineer. R. L. Williams was in charge during part of the construction period. Dr. F. E. Hance of the Hawaiian Sugar Planters Experiment Station contributed to tests and soil theory, while M. C. Dease was in charge of the testing laboratory during the final construction period. Kirk Miles was a junior engineer during the last year. The contractor, S. Nakao, is largely responsible for the loyalty and efficiency of the construction forces.

Advanced American Practice Followed in Japanese Sewage-Treatment Plant

Kyoto adopts combined activated-sludge and separate-sludge digestion with mechanical equipment throughout

By Joseph Delano Hitch
Sanitary Engineer, The Dorr Co., Inc., Tokyo

KYOTO, a city of 760,000 population about 320 miles west of Tokyo, Japan, is building a sewage-treatment plant of highly modern type, in which activated-sludge treatment and separate-sludge digestion will be combined. Although its capacity is 5 m.g.d., the plant is to be classed as an experimental one because it will be used to test out the efficacy of the activated-sludge process on dye-house wastes mixed with domestic sewage, and will serve as the proving ground for the working out of a method of treatment to be used ultimately for handling the entire sewage of the city. Several Japanese cities have adopted American sewage-treatment methods in part, but Kyoto is the first to adopt them in their entirety and the first to utilize mechanically operated equipment throughout.

Kyoto's sewage contains about 250 p.p.m. of suspended solids and at times contains as much as 20 per cent dye-house wastes and 30 per cent infiltration. The average flow for which the plant is designed is 8 cu.ft. per second. (Minimum daily 5, maximum 12; the hourly rate occasionally may be as high as 16.)

Screening and Grit Removal—The raw sewage will pass first through a 4x3-ft. bar screen with ¼-in. steel bars set to give a 1-in. clear opening. The accumulated coarse solids will be removed by a mechanically operated cleaning device equipped with a float-operated switch that operates the rakes automatically when the screens cause a loss of head of a predetermined amount through the screen.

Directly downstream from the bar screen there is a mechanically operated grit chamber and grit-cleaning channel. The grit chamber, 14 ft. square, is cleaned by a revolving mechanism driven by a traction wheel at the periphery, and the grit-cleaning channel (21 in. by 26 ft.) is cleaned by a reciprocating rake that delivers the washed inorganics several feet above water level.

Preliminary Settling—From the grit chamber the sewage flows through a recording and indicating venturi meter and thence to pumps that elevate it 15 ft. to the preliminary sedimentation tank. This tank is to be 80 ft. square. Settled solids, collected by a mechanically operated sludge-collecting mechanism, are transferred by diaphragm pump to a separate sludge-digesting tank, 65 ft. in diameter by 27 ft. deep, equipped with a revolving stirring mechanism and arranged for the collection of the sewage gas and its utilization to hold the sludge at 80 to 90 deg. F.

Aeration—The effluent from the preliminary sedimentation tank will flow to the aeration units, but a bypass is provided so that a portion may be diverted to the river without secondary treatment. The aeration capacity at this time will not be sufficient to treat all of the sewage, especially when the dye-house wastes constitute a large portion of the total, but by virtue of the bypass arrangement the aeration tanks can be tested out on a wide range of flows, and the performance record can be used in extending the plant.

Final sedimentation after aeration takes places in a basin 60 ft. square, also equipped with a revolving sludge-collecting device, from which excess sludge is returned to the channel leading to the primary sedimentation tank. Digested sludge will be dried on open beds of the conventional type and sold to farmers as a mild form of fertilizer.

T. Chujyo, chief engineer of the Kyoto sewerage department, developed the design of the plant on the basis of his observations during a visit to the United States and study of many sewage-treatment plants of various sizes and types. It may be of interest also to note that the mechanical units, including screens, grit chambers, clarifiers, digester and sludge pumps, were built to the designs of the writer's firm by Japanese labor in local machine-building plants.

Mississippi Levee Building

A new record was made in August for amount of earthwork placed in a month in the Mississippi River flood-control levees. The total was 17,588,000 cu.yd., of which 16,500,000 cu.yd. was placed in levees on the main river project below Cape Girardeau. In July nearly 15,000,000 cu.yd. was placed, the two months totaling 40 per cent of the amount placed in the year ended June 30, 1932. The Bird Point-New Madrid setback levee is 98.1 per cent complete. The Bonnet Carré spillway structure and side levees are complete except for gaps left for bridges. To the end of August 266,500,000 cu.yd. has been placed under the present flood-control act.

Lessons From Hurricanes in Puerto Rico

Structures wrecked in wind of Sept. 27 were of inadequate construction—Anemometer again destroyed—Design changes suggested for structures in hurricane areas

By Manuel Font
Electrical Engineer, Public Service Commission of Puerto Rico, San Juan, Puerto Rico

CYCLONIC disturbances of destructive intensity are becoming so frequent in the West Indies that designing engineers working in this part of the tropics would do well to revise their wind-load schedules. On Sept. 26 last (these disturbances usually occur between the months of August and October) a cyclone with a wind velocity estimated at between 130 and 140 miles per hour visited Puerto Rico, destroying reinforced-concrete buildings, steel-framed structures, transmission-line towers, pier sheds, chimneys and coal-handling gantry cranes; blowing railroad freight cars off the tracks; devastating large residential and slum areas and causing hundreds of casualties.

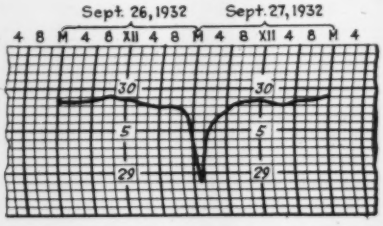


Fig. 1—Graph of barometer pressures records hurricane's progress. U. S. Weather Bureau warning prophesied storm's arrival at midnight, a very close estimation.

On the morning of the 26th, the U. S. Weather Bureau station in San Juan, Puerto Rico, issued the following Bulletin No. 1:

"Sept. 26th, 1932—Warning of cyclone, 9 a.m. A hurricane of moderate but increasing intensity is centered apparently between St. Kitts and St. Thomas. It will affect the Virgin Islands this afternoon and the east of Puerto Rico toward midnight. Take all precautions.—Hartwell."

With almost mathematical accuracy the hurricane arrived by midnight. Fig. 1 is the barometer record for the period between midnight of Sept. 26 and midnight of Sept. 28, and it shows that the lowest barometric pressure registered was 28.85 at about one o'clock in the morning of September 27.

The maximum velocity of the wind during the hurricane can only be guessed at because the anemometer tower (Fig. 2) of the U. S. Weather Bureau station was blown down when the wind velocity registered had reached 72 miles per hour; but conservative observers estimate it as between 130 and 140 miles per hour, as stated before, although gust velocities were probably much higher. Four years ago, during the hurricane of Sept. 13, the wind velocity reached a maximum of 160 miles per hour. Such wind velocities naturally produce tremendous pressures, and if the wind can penetrate into buildings through openings or broken transoms and windows facing the direction of the moving cyclone, as it did in a good many cases, the loading produced by the wind may be as high as three times the velocity pressure, at least on small areas. Only this fact can explain the collapse of reinforced-concrete and steel-framed struc-

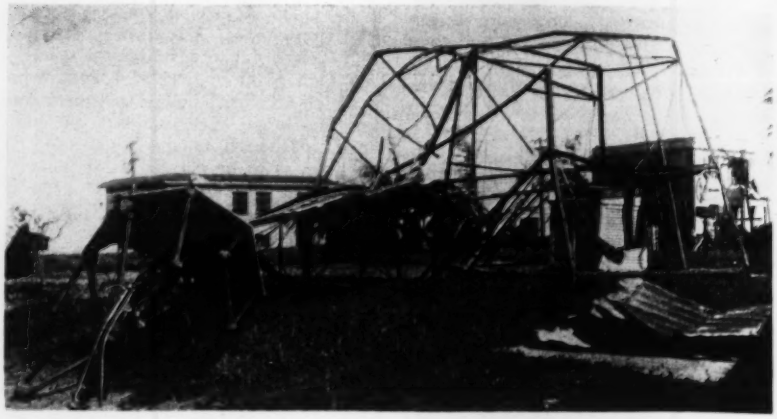
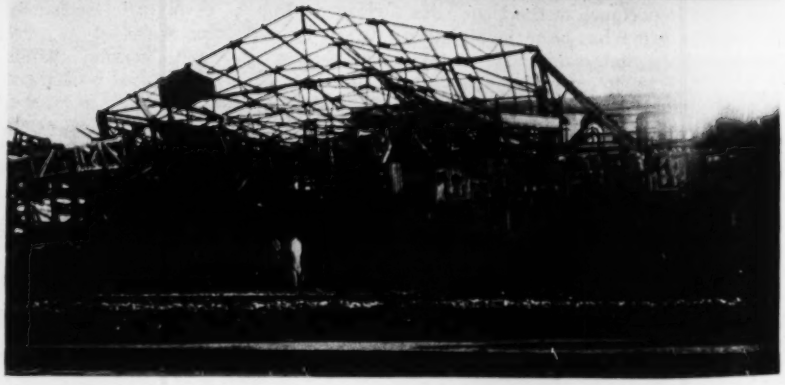


Fig. 2—Wreckage of anemometer tower at U. S. Weather Bureau station. Maximum wind velocity registered was 72 miles per hour.

Fig. 3—Both steel and concrete structures were badly damaged, but all showed lack of adequate design, including insufficient bracing, poorly installed reinforcing steel and columns with high slenderness ratios.



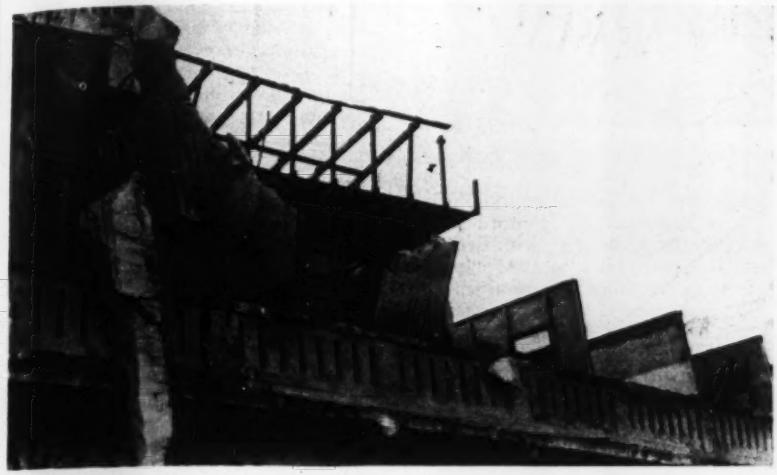


Fig. 5—Two-story concrete building with wooden partitions was easy prey to the hurricane winds.

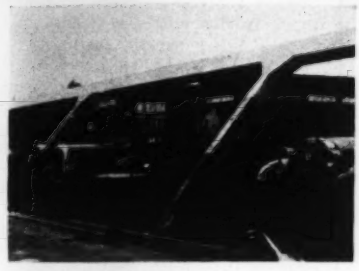


Fig. 4—Concrete bent blown down its entire length as a result of inadequate anchorage.

tures (Fig. 3). It is true that all concrete buildings that failed were unimportant structures, and in all cases examined by the writer the reinforcement was either insufficient or wrongly placed, or both conditions obtained; nevertheless, failures even under these circumstances can be explained only on the theory that the wind loading reached two or three times the velocity pressure. In the case of the steel-framed structures examined by the writer the bracing was in every case insufficient, and in one particular case there was not only not any bracing between columns but the columns had excessive slenderness ratios.

About 70 per cent of the transmission-line towers of one of the power companies were blown down and will have to be replaced. In this particular case the line runs for many miles through open country offering no protection. The towers are of tubular construction.

Hurricane lessons

The lessons to be derived from the effects of this and previous hurricanes as observed by the writer may be summarized as follows:

1. The wind loadings now used in design must be raised. The value recommended is 75 lb. per sq.ft.

2. Reinforced-concrete buildings, when well designed and properly constructed, are cyclone-proof. They have the added advantage of being earthquake-proof.

3. Windbracing and windbracing connections for steel-framed structures must be matters of careful study and design and not of haphazard estimate.

4. Tile roofs, corrugated iron roofing, roofing paper, copper shingles, etc., are insecure and an element of danger during cyclones. A large number of deaths was caused by flying roofs striking neighboring houses and individuals.

5. The only cyclone-proof roof is the reinforced-concrete slab, when well designed.

6. No transoms on the outside doors or windows should be used. When outside glass windows are used the glass should be reinforced.

7. Roofs having four sloping sides are more resistant than those having only two.

8. The ordinary hardware used on doors and windows is not strong enough. The old-fashioned cross-beam, fitting into Z-shaped pieces screwed on the jambs, is the only dependable device to keep doors and windows from flying off.

9. Overhanging ornamentation on structures, especially on buildings, is an easy prey to the wind and an element of danger.

10. Glass marquees and porte-cochères are easily destroyed by the wind and flying pieces of roofing material.

11. Roof trusses when used must be securely anchored to the walls of the buildings.

12. In the case of power, telephone and telegraph lines it is more economical to insure than to build them cyclone-proof.

Checking the Design of Rectangular Timber Beams

By C. K. Clausen
Seattle, Wash.

THE DESIGN of rectangular timber, joints, beams and girders can be quickly checked by applying the following formulas, all derived as special cases of the fundamental equations of applied mechanics. The conditions of simple support and uniform loading are assumed.

1. Bending stress $= f = \dfrac{1.5\ w\ CL^2}{S}$

2. Horizontal shear stress $= f = \dfrac{w\ CL\ d}{8\ S}$

When the allowable fiber stresses are 1,800 lb. per sq.in. in bending and 165 lb. per sq.in. in horizontal shear and a modulus of elasticity of 1,650,000 lb. per sq.in. is assumed:

3. Allowable load $= w = \dfrac{1200\ S}{CL^2}$ (bending)

or $w = \dfrac{8\ f_s}{CL\ d}$ (horizontal shear).

4. Required section modulus

$$= S = \frac{WL}{1200} \text{ (bending)}$$

or $S = \dfrac{Wd}{1320}$ (horizontal shear).

5. Maximum deflection $= \dfrac{WL^3}{36{,}666\ Sd}$

In the foregoing formulas: w = load, lb. per sq.ft. W = total load, lb. f = fiber stress, lb. per sq.in. b = width of beam, in. d = depth of beam, in. L = length of span, ft. C = spacing of beams, ft. S = section modulus, cu.in. D = maximum deflection, in. The use of the formulas is facilitated by the following table:

SECTION MODULUS OF RECTANGULAR TIMBER BEAMS

Nominal Size	Section Modulus			Nominal Size	Section Modulus		
	Rough	*SIE*	*SISIE S4S*		Rough	*SIE*	*SISIE S4S*
1x4	2.67	2.0	1.5	8x12	192	176	165
2x3	3.0	2.3	1.9	8x14	261	243	228
2x4	5.3	4.4	3.6	8x16	341	320	300
2x6	12	10	8	8x18	432	418	392
2x8	21	19	15	8x20	533	506	475
2x10	33	30	24	10x10	167	150	143
2x12	48	44	36	10x12	240	220	210
3x4	8	6	5	10x14	327	304	290
3x6	18	15	13	10x16	427	400	382
3x8	32	28	23	10x18	540	512	486
3x10	50	45	38	12x12	288	264	252
3x12	72	66	55	12x14	392	365	350
4x4	11	8	7	12x16	512	480	460
4x6	24	20	18	12x18	648		
4x8	43	37	33	12x20	800		
4x10	67	60	53	12x24	1,152		
4x12	96	88	77	14x14	457		
4x14	131	121	106	14x16	596		
6x6	36	30	28	14x18	756		
6x8	64	56	51	14x20	933		
6x10	100	90	83	14x24	1,344		
6x12	144	132	121	14x26	1,577		
6x14	196	182	167	14x28	1,829		
6x16	256	240	220	16x20	1,067		
8x8	85	75	70	16x24	1,536		
8x10	133	120	113	16x30	2,400		

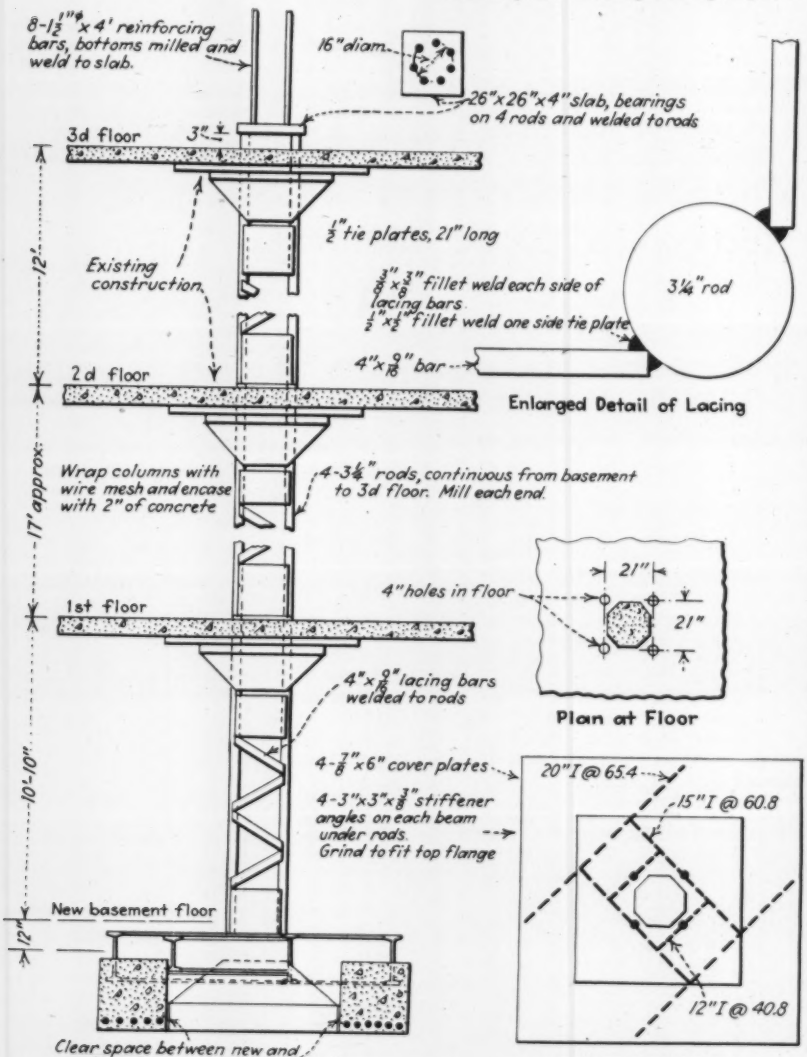
Adding Stories to Old Concrete Buildings

By Henry Bittman
Architect and Engineer, Seattle, Wash.

PROBLEMS encountered in adding six stories to a two-story concrete building in Seattle that had no provision in the original design for increased loading resulted in a simple but rather unusual solution in column design and construction. Four steel rods 3¼ in. in diameter placed around the old concrete columns, stiffened by welded lacing bars and finally incased in concrete, carry the load from the new floors around, and not into, the old columns. The method is considered of interest because of the increasing frequency with which this problem of altering existing concrete buildings is being met by the structural designer.

The Lowman and Hanford Building is 80 x 108 ft. in plan, with two stories and basement, built in 1922; floors are of typical flat-slab construction, including drop panels and column capitals. No provision for additional stories was made in either original columns or footings of the building. They were of minimum size and stressed to maximum permissible building-code limits under existing roof and floor loads. The property has increased in value, and the owners are at present adding one additional story with plans for five more within a few years, all to carry quite heavy loadings. Treatment of a typical interior column, for an additional load of 440,000 lb., is shown in the accompanying drawing.

Fabricated in the field by welding, unique columns permit extending building height.


8-1⅜" x 4' reinforcing bars, bottoms milled and weld to slab.
16" diam.
26"x26"x4" slab, bearings on 4 rods and welded to rods
3d floor
3"
½" tie plates, 21" long
Existing construction
⅜"x⅜" fillet weld each side of lacing bars
½"x½" fillet weld one side tie plate
3¼" rod
4"x⅜" bar
2d floor
Enlarged Detail of Lacing
Wrap columns with wire mesh and encase with 2" of concrete
4-3¼" rods, continuous from basement to 3d floor. Mill each end.
12'
17' approx.
4" holes in floor
21"
21"
1st floor
4"x⅜" lacing bars welded to rods
Plan at Floor
4-⅞"x6" cover plates
4-3"x3"x⅜" stiffener angles on each beam under rods. Grind to fit top flange
20"I @ 65.4
15"I @ 60.8
12"I @ 40.8
10'-10"
New basement floor
12"
Clear space between new and existing footings
Old and New Footing

A new footing of required bearing area is built to inclose the existing column footing, and a framing of I-beams is constructed, which bears upon the new footing and spans above but does not bear on the old one. This I-beam framing supports the new column, a square latticed section that is assembled and welded in the field. Four continuous round bars, 3¼ in. in diameter and 40 ft. long, milled top and bottom, form the new column and are lowered from the roof through 4½-in. holes drilled in the existing roof, floor slabs and column capitals. These bars are then spot-welded to the I-beams of the footing, and at their tops, a few inches above the present roof slab, they are welded to a heavy steel plate upon which the new reinforced-concrete column of the upper stories will seat. These stub bars are welded to the steel plate to provide positive connection.

No bond to old concrete

After welding the latticing and batten plates to the vertical bars the new columns are incased with a 2-in. concrete fireproofing. This concrete incasement will be poured against the old column, but no attempt will be made to clean or roughen the surfaces of contact, and the bond between the new and old concrete will be slight. In the zone where the main bars pass through the floor slabs and column capitals they will be greased and then the holes will be filled with mortar. It is the intention to have the existing columns carry the loads of the existing floors and the new work carry the loads of the added stories.

The question as to the advisability of this separation is one that naturally arises. If the contact between the new and the old concrete should be intimate and complete, axial deformations due to new loads would be equal in the new and the old concrete, but in the case of the old column these deformations would be in addition to those already existing by reason of the old floor loads. With the old concrete column contained in and confined by the new concrete, with its added resistance against lateral expansion, no practical harm to either the column or to the building could have resulted from any increased deformation. But inasmuch as such increased deformations can only be interpreted as evidence of increased stress, and inasmuch as existing stresses in the old column are already of maximum permitted code value, there can be no question but that bond between the new and the old concrete would have gravely and seriously increased the stresses above building-code values. Consequently bond is being avoided.

The contract is being executed by the J. W. Bailey Construction Co. The writer is architect and engineer.

Construction Reviews Its Problems

Five-day meeting at Washington of the Associated General Contractors, the Construction League of the United States and the National Conference on Construction takes action on current problems confronting the construction industry

THREE construction groups representing leadership in all branches of the industry met Oct. 9-14 in Washington, D. C., and took action on various problems of technique, finance, insurance and internal organization and business practices. About 150 representatives, including engineers, architects, contractors, realtors, insurance officials, financiers, manufacturers, producers, distributors and economists attended the meetings of the three groups, and many of them continued in attendance throughout all the meetings of the five days. The subjects touched ran into scores, but many of them were quickly dismissed as reports of progress or routine, leaving perhaps a dozen that commended themselves for attention in a running summary. This is given in the form of a separate account of the meeting of each group.

* * *

Building Construction Conference

THE CONFERENCE on building held under the auspices of the Department of Commerce and the United States Chamber of Commerce considered a program of six formal committee reports and a number of talks on federal aid of building for slum removal, staggering employment in construction and R.F.C. loan policies. A few more than 100 were registered for the meeting, and about that number was in attendance during presentation of the committee reports, which were confined to the sessions of the first day. Conclusions and recommendations following out of the first day's sessions were adopted at the concluding session on the second day, and the papers on staggering employment and on slum removal were presented.

A number of the committee reports presented facts and experience of fundamental value which will be summarized separately in future issues. In this account only the general findings and recommendations are outlined.

Local construction inventories

Five studies embracing construction inventories, the U. S. construction census, employment statistics, principles of statistics and a bibliography of construction were made by the committee on business reports, statistical and trade information, and a report was presented on each study. Principles of construction statistics were outlined, and brief commendation was given to the construction census and the work of the Department of Labor in collecting employment statistics. Recommendations were made that these activities should continue.

Principal attention was given to the development of construction inventories. The purpose back of such inventories is to develop a picture of the demand and supply of construction in a given locality. The report outlined the main factors of such a picture as applied principally to residential construction. Among the principal factors is occupancy of existing buildings, and particular study was made of occupancy surveys. Through the cooperation of the division of housing of the Department of Commerce a monograph on how to make an occupancy survey was prepared and is embodied in the committee's report. A separate section of the report discussed the activities required to arouse community interest in originating and continuing local construction inventories. The desirability of continuing periodic surveys was stressed in the report and the discussion that followed. The discussion also brought out that, using existing civic and business agencies, the cost of these surveys would be moderate.

Elimination of wastes

Principal consideration had been given by the committee to, and reports were presented on the reduction of costs by accident prevention and on losses through seasonal operations and on training of apprentices and planning. Memoranda were also presented on mechanics' liens, building codes and quantity surveys as influences affecting construction wastes.

The reports on accident prevention and seasonal operations are reserved in their factual details for future separate presentation. In general, in respect to accident prevention, the report emphasized the indirect losses from accidents as amounting to far more than the amounts paid by the insurance companies in settling claims. The indirect losses were estimated as four times the sum of the claims paid, this estimate being based on a study of the loss in time, delays, reduced morale and other factors. In respect to seasonal operation it was announced that the technical features of the problem (winter work) have been ably attacked. At present the principal influence continuing the enormous losses that result from the highly seasonal variations in the operations of the construction industry is the fixed leasing date.

Present building-code practice was stressed as a cause of waste and unnecessary cost. It was urged that there be provided for certain low-rental residence construction code provisions less severe than those applying to normal construction. Further, it was advised that agencies be set up authorized to consider appeals from code provisions, to interpret all provisions and to consider the acceptability of new products developed since the writing of the code.

Further standardization and simplification of materials were recommended, and it was urged that similar action be taken by architects in specifying products standardized as to dimensions and quality. The need to provide locally for better credit information was suggested. Particular attention was called to the work of the bureau of contract information, and it was recommended that all branches of the industry should support that bureau. Inspection practices were mentioned as contributing to waste, particularly in municipal operations. It was suggested that effort be made to establish in each community an independent inspection agency which could function for all municipal operations. In conclusion, stand was taken against the use of foreign materials in government work and in construction operations aided by the R.F.C.

Realty finance

Three activities in particular of this committee, it was stated, have been the sponsorship of a local construction inventory in Cleveland, Ohio; a study of appraisal practices, including a statement of appraisal principles; and the development of a uniform mortgage law.

Cooperating with the committee on statistics to provide a demonstration survey, a committee called the committee on real property inventory was created in Cleveland, Ohio. To make this effort most effective, it was decided to carry out the enterprise only if the banks interested in realty finance requested it, helped to finance it and actively participated in it. The banks readily agreed that it was a necessary enterprise for regulating building financing, and the Cleveland Clearing House made a contribution on behalf of all the banks. A total of $15,000, sufficient to carry on the initial survey, was assured by interested groups. A member of the

staff of the National Conference on Construction has been designated technical associate in carrying out the operations, and the staff direction of the enterprise is under a Cleveland member of the National Conference Committee on Statistics, which developed many of the principles being applied. An inventory of existing property and a survey of occupancy, noting the "doubling up," is to be undertaken with the cooperation of the post office. New construction is to be recorded as well as new subdivision activity. Procedures are being set up for recording deeds, mortgages and foreclosures. Movements of population are also being checked. All data are being gathered for separate small divisions of the city, designated as census tracts by the Bureau of the Census.

In the matter of appraisals the committee found general agreement that present practices are not satisfactory. It had recommended that a national body of appraisers be organized that would demand of its members qualifications as to education, experience and character, but since the drafting of this recommendation there had been organized the American Institute of Real Estate Appraisers of the National Association of Real Estate Boards, designed to qualify appraisers and to determine sound practices. A code of appraisal principles was presented, which proved one of the most complete documents of the conference and which will be taken up for separate consideration in a future issue.

Economic relationships

This committee, summarizing in ten counts the basic defects existing in the organization of construction, presented first a brief for the agency type of contract as a means of improvement in certain types of building work and, second, outlined means being practiced in several communities to eliminate bid peddling. If building construction is to operate on a sound basis, a satisfactory solution must be found for following prevalent conditions:

1. Greatly added ultimate cost and unsatisfactory performance result from the failure of the owner to limit the bids to competent and experienced contractors.

2. The duplication of effort that results from the presentation of bids by an excessive umber of bidders results in a substantial economic loss.

3. Insufficient investigation on the part of bonding companies and the owner, lack of information and lax standards of materials suppliers in their credit practices result in artificially establishing responsibility for financially weak general contractors and subcontractors. Lien laws in many states make it possible for a vendor of material to a contractor to collect from an owner for this material, even though the owner has already paid the contractor for the same material. This makes it possible for vendors of material to disregard the credit standing of the contractor to whom they sell, and it destroys the advantage that a contractor of high credit rating should enjoy.

4. Employment by the architect or the owner of inexperienced and incompetent inspectors not qualified to pass on construction details and lacking in practical construction judgment results in lack of cooperative effort between the contractor and the inspector, and in the case of an unscrupulous contractor permits the execution of work inferior to that which is specified. This, in turn, places an unfair burden on the contractor who desires to observe ethical standards.

5. Carelessly drawn and indefinite specifications make it possible for a contractor to make claims for unnecessary and unforseen extras, or to reduce the cost of the work at a severe sacrifice of the quality. This places the ethical contractor at a great disadvantage in presenting his bid, since a contractor desiring to maintain a high reputation must refuse to adopt such shrewd and questionable tactics.

6. Loose and non-comprehensive specifications are frequently the result of the failure of the engineer and architect to maintain a close contact with competent contractors, subcontractors and materials producers who are familiar with the latest practices and possess the best data.

7. In the design of important buildings serious losses frequently occur through the failure of the owner and architect to call in as consultants, in the early consideration of the project, experts in the field of construction, finance and building operation.

8. A tendency on the part of general contractors to use unscrupulous methods in obtaining a price less than that officially bid by the subcontractors usually involves financial loss to the subcontractor and inferior work for the owner. Subcontractors are also guilty in permitting and even encouraging this cutting under their bid figures after the bids have been submitted.

9. Many of the above defects are due to the lack of a cooperative relationship between the owner, the architect and the general contractor.

10. In the construction of large office buildings the general contractor has often been employed on an agency or semi-professional basis for the purpose of securing better cooperation between contractor, architect and owner, a system that has many advantages in this field of work. Many possible advantages are nullified, however, when the contractor attempts to assume the dual role of professional advisor on one contract and competitive operator on another contract simultaneously, thereby exposing himself to the temptation of using his most efficient workers on the lump-sum or competitive job; also when he undertakes the purchase of materials or performance of subcontract operations for profit on a job that he is handling on a professional basis.

Bid peddling was made a separate charge of evil practice by the committee. It was considered that reform can be brought about only by an extended educational program conducted by the industry. A number of methods that have been adopted to prevent the evil were outlined with the warning that, in introducing new arrangements, opportunities are often made for establishing new evil practices.

Local organizations

Based on questionnaires, this committee presented a summary of the types of local building associations that have developed throughout the country and concluded that "no one particular type of comprehensive local organization is inherently superior to any other type." The merit of any such organization lies in its adaptability to the specific conditions existing in the particular community. Among the principal factors determining the type of organization are population, labor situation, present local trade associations and type of local leadership available.

* * *

Associated General Contractors

FEDERAL loans to aid construction, direct federal construction programs and federal legislation affecting construction had major attention in the fall meeting of the governing boards of the Associated General Contractors. A definite committee set-up was announced to adjust differences on questions of surety bonding practices. In this connection the bureau of contract information stated that performance records of 9,952 contractors were on file and that 27,332 reports had been made, about half to surety companies, financial institutions, manufacturers and distributors, and half to agencies awarding public and private contracts. The award of contracts to irresponsible low bidders had been prevented by the bureau in 743 cases.

Resolutions were passed against motor-vehicle tax diversion; in favor of a system of licensed realty appraisers and standard methods of appraisal; and in favor of creating an inter-industry committee to act on legislation affecting construction.

Prevailing-wage law

Accumulating evidence of the unworkability of the Bacon-Davis prevailing-wage act governing wages on federal public-building construction and failure to secure a remedy because of veto by

the President of the amended act passed by Congress were considered to suggest the wisdom of legal action in a discussion by Herman J. Galloway, attorney, of Washington. Reviewing the law, Mr. Galloway indicated that five questions of legality and interpretation arose: (1) Is the statute valid? (2) Does it mean that the wages to be paid are those prevailing at (*a*) the date of the bid, (*b*) the date of the contract, or (*c*) the date of doing the work? (3) Has the Secretary of Labor any jurisdiction to make a determination if the contractor and the contracting agency have agreed? (4) Is the union wage scale the prevailing wage as the term is used in the statute? (5) May the Secretary of Labor in making his determination consider or apply the wages paid in any civil division other than that in which the building is located?

Validity arguable

In answer to the question of validity it was pointed out that court decisions had held state prevailing wage laws invalid in Oklahoma, Texas and Illinois. The Oklahoma and Texas laws were criminal statutes and were declared invalid because uncertainty in definition of criminality was involved in such terms as "prevailing" and "locality" so that that crime could not be determined. In the Illinois case a decision was rendered on a basis having little application to the federal statute. On the basis of court decisions, then, validity of the Bacon-Davis act is very arguable, but there is no assurance that a decision of invalidity would be probable.

On the second question it was considered that it could be held successfully that any date but that of the contract or of the bid is an unreasonable interpretation of the statute. It seems fairly certain also that the answers to the remaining questions are that the Secretory of Labor has no jurisdiction where wages have been agreed upon by the contractor and the contracting officer, also that the union scale is not the prevailing wage unless it is in fact the scale that prevails, and, finally, that wage scales in force outside the civic division in which the work is located cannot be recognized in determining the prevailing wages.

It was considered that if contractors desire relief from the bad situation created by the Bacon-Davis law, they should seek a court decision on the questions named.

No action was taken by the meeting. It was indicated, however, in the report of the legislative committee that efforts would be continued to put through the next Congress the ammended act that was vetoed at the last session.

Federal construction activities

Discussion of the Reconstruction Finance Corporation policies and activities brought out sharp criticism of that body from various speakers, both for its inaction and its drastic requirements for loans asked. Speaking as a member of the committee on trade recovery, W. G. Luce stated that contacts with the R.F.C., which had been quite discouraging at first, were becoming more cordial. It seemed now that a real disposition was developing to make the R.F.C. a service to construction. The discussion did not head up in action by the meeting.

Continuing the consideration of federal credit for construction, Nathan Adams, one of the directors of the new institution, discussed the policies of the new home-loan bank act. Mr. Adams indicated that if mortgagees took full advantage of the credit facilities of the new bank, about $1,500,000,000 would be set free for use in the financing of homes.

Reviewing federal building work, Perry K. Heath, assistant secretary of the treasury, stated that the monthly expenditure was running about $10,000,000 and that this rate would continue for the next twelve months. At present, in a building program of $700,000,000, 239 buildings have already been completed, involving an expenditure of $89,391,219. There is available for work $496,463,942 authorized by Congress in addition to the $100,000,000 provided in the relief act. There are under contract buildings costing $311,472,923, and sites have been purchased in the District of Columbia costing $28,047,504. A total of 121 buildings, costing $38,340,300, is about ready for bids.

Staff operations

Important items of the staff operations reported were the completion of the code of bidding and awarding practices, revision of the standard questionnaires for prequalification of contractors, a model law for building appraisers and revision of the A.G.C. manual. Active work has been continued in promoting safety measures and developing rules for accident prevention.

* * *

Construction League

NEARLY two-score questions for consideration were promptly disposed of in the meeting of the policy committee of the Construction League of the United States held at Washington, D. C., Oct. 12. Outstanding reports were presented on the work of the committee on trade recovery, the committee on large-scale housing and the committee on a code of practice for the construction industry. A brief report on the work of the bureau of contract information was given commendatory notice. It was brought out that the voting strength of the organizations now members of the league aggregated about 115,000 individual members and that in addition these organizations had some 6,500 honorary, company and junior members. The treasurer's report showed a balance in the treasury. The membership committee reported increasing association interest in the work of the league and an announced disposition to take up membership as soon as association finances improved.

A notable piece of work was disclosed in the preliminary draft of a trade practice code. These rules were submitted with the recommendation that a trade practice conference be appointed and authorized to make application for a trade practice conference under the Federal Trade Commission. The code drafted contains 30 rules grouped in two classifications: (1) rules enforceable by federal law, and (2) rules enforceable by agreement. This code will be published in substance in another issue.

Large-scale housing

The report on large-scale housing, as presented by Robert D. Kohn, reviewed the present legal set-up for such operations and some of the economic limitations to their successful undertaking. At present only New York State has a housing law, although Ohio has passed such a law, which will be in effect Jan. 1, 1933. Progress in legislation has been slow in other states. Illinois has prepared a law, and preliminary steps have been taken to secure legislation in Wisconsin, North Carolina, California and New Jersey. Legislation was introduced in Pennsylvania and Indiana and failed. Mr. Kohn called attention to possible dangers in drafting too much of the New York law into acts for other states, as New York had quite different problems to solve. In general, he stated, real-estate interests were in opposition to housing legislation because of its effect on the leasing value of existing properties. Definite economic limitations, Mr. Kohn pointed out, were placed on such projects by interest rates and land costs. A dollar added to the square-foot cost of land increased the monthly rent per room about 60c., and 1 per cent increase in interest rate added $1 rent per room per month.

Improved RFC contacts

In reporting on the work of the National Committee for Trade Recovery W. G. Luce stated that 46 committees were actively at work in 43 states. The first task of the national committee had been to get the law, and now it was to activate its service first by continuous contact with the R.F.C., and second by persuading the public to activity in applying for loans. The encouraging statement was made that the attitude of the corporation toward borrowers was improving and that a material hastening of loans could be anticipated.

Book Reviews and Notes

A Monthly Commentary on Current Additions to the Civil Engineers' Library

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Marine Borers in Australia

DESTRUCTION OF TIMBER BY MARINE ORGANISMS IN THE PORT OF SYDNEY—By Tom Iredale, R. A. Johnson and F. A. McNeill. Paper; 7x10 in.; pp. 148; numerous diagrams and photographic illustrations. Published by The Sydney Harbour Trust, Sydney, Australia.

In 1927 the Sydney Harbour Trust Commissioners began a study of means for checking the destructive activities of marine borers along the shores of Port Jackson, New South Wales, the 15-mile deep estuary on which Sydney is located. Port Jackson is located in the temperate zone and has 180 miles of foreshore, 9 miles of which is developed for commercial purposes. Marine borers are active in the entire area.

The present report is one of progress and preliminary observations as to the character and distribution of borers found, their habits and sustenance. Protective measures employed are outlined and results obtained to date are summarized. A brief comparison of results obtained in harbors north of Port Jackson is included.

* * *

The Washington Mushroom

OUR WONDERLAND OF BUREAUCRACY—By James M. Beck, former solicitor general of the United States. Cloth; 6x9¼ in.; pp. 272; unillustrated. Published by The Macmillan Co., New York, N. Y. $3.00.

In these days when everyone is more than normally conscious of the cost of government there is increasing demand for factual information as to why such costs have increased so enormously and how the growth can be checked or reduced. In so far as the federal government is concerned this book by James M. Beck, former solicitor general of the United States, answers the first question. By analogy the manner in which state and local governments have grown is demonstrated. How the growth can be checked is indicated but not answered; in fact one effect of the picture Mr. Beck paints is development of a sense of hopelessness over ever checking the growth of government bureaus and departments. All attempts so far made to reorganize the government or to eliminate much duplication and waste have failed because those who could have made them effective—even up to the President himself—have been fearful of the effect upon their own job, that of their friends or upon their party.

Mr. Beck's book is well written. Engineers will find in it too much emphasis on the legal side, too much worship of the Constitution and an inclination to determine the need for any particular department or bureau on the basis of whether or not it is constitutional rather than upon whether it serves a useful and justifiable purpose—but then Mr. Beck is a constitution lawyer. The discussions of constitutional law may be skipped.

* * *

Social Housing Problems

HOUSING AND THE COMMUNITY-HOME REPAIR AND REMODELING—Cloth; 6x9 in.; pp. 291; halftones and line drawings. Published by The President's Conference on Home Building and Home Ownership, New Commerce Building, Washington, D. C. $1.15 (foreign $1.25) postage prepaid.

An unusual approach to community housing problems is recorded in Vol. VIII of the reports of the President's Conference on Home Building and Home Ownership; the problem is there approached from the medical and sociological rather than the economic viewpoint. Housing and health and housing and safety as well as the relations of housing to delinquency, to efficiency of industrial workers and to citizenship are discussed. These subjects may appear far removed from engineering, and yet they cannot be ignored in regional or town planning work if the results are to approach the ideal solution. In fact, the committee that prepared the report cites the need for further research along these lines as a fruitful one for study by the departments of sociology, engineering and medicine in our universities. Another fruitful field for research by engineering schools or for a well-endowed foundation is outlined in the second report made a part of this volume, the report of the committee on home improvements and remodeling. This committee points out the need for analysis of the type and rate of depreciation and obsolescence of each part of a house.

* * *

Preserving the Morale of the Unemployed

EMERGENCY WORK RELIEF—By J. C. Colcord, W. C. Koplovitz, and R. H. Kurtz. Cloth; 6x9 in.; pp. 286. Published by the Russell Sage Foundation, New York, N. Y. $1.50.

"Work relief is certainly no solution for the problem of *unemployment;* it remains to determine how effective it may become in offering a solution for some of the problems of *unemployed individuals.*" With these words the authors conclude their discussion of a survey of emergency work-relief programs carried out during 1930 and 1931. The study was made in response to a request from the President's Organization on Unemployment Relief. Thirty communities were visted by Miss Colcord and her associates during the summer and early fall of 1931 and their book contains reports on work relief carried on in 26 of them, chiefly situated in the middle, eastern and southern states.

Three types of approach toward work relief were discerned in the various communities visited. One type viewed with distrust the desire of the majority of the unemployed to work and adopted a "work or starve" attitude. This view, the authors state, has been completely discredited. A second type stressed the economy features of work relief considering that the community should get as much as possible in return for its relief contributions. The third attitude considered work relief principally as a way of preserving the morale of the recipients of relief, with return to the community as incidential. The authors hold the third type of view.

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Foundation Problems

Reviewed by George Paaswell
Consulting Engineer, New York, N. Y.

DER BAUGRUND—By M. Singer. Cloth; 6x9 in.; pp. 393; numerous illustrations. Published by Julius Springer, 1 Schottengasse, 4, Wien (Vienna), Austria. 28 marks.

KRITISCHE BETRACHTUNG VON FLACH und Pfahlgründungen besonders in dem Hafenplatzen Niederlandisch-Indiens—By Wilhelm Loos. Paper; pp. 24; numerous illustrations. Published by Julius Springer, Berlin. 4 marks.

NO ONE would controvert the statement that the geologist can give valuable aid to the engineer in connection with soil studies for foundation and general construction in earth works. It is unfortunate, therefore, that the geologist and his texts generally make little practical contact with the engineering problems involved in soil studies. The engineer, left to his own resources, makes an empiric classification of soils that bears little or no relation to the geologic history of the deposit. No branch of the engineering profession is so replete with failures, both partial and complete, as foundation practice and earthwork construction in general.

The author of the first book noted above, *Der Baugrund,* has covered the formation of the deposits on the earth's crust, discussing the effect of climate, wind, coast erosion and basin deposits in both past and present geologic ages. The very important factor of the glacial ages is exhaustively described. There is a growing realization that foundation studies are very incomplete and consequently exceedingly dangerous, when such studies explore only the layers im-

mediately below the plane of applied loading. A profile drawn up of a given soil, which is a proper geologic picture deduced from intelligent boring records, forms a rational guide to the behavior of structures built up on this soil. The geologic factors are comparatively simple and of easy interpretation. It is this fact that renders the book under review so valuable to the engineer. Ground movement, whether slight, such as the settlement of a building, or on a grand scale, such as landslides, are all predictable when the geologic picture is completely drawn. The author has done valuable service in giving an unusually complete picture of the subsoil formations of practically all the large cities in Europe as well as of North and South America. There is a brief chapter on soil mechanics. The subject of groundwater and its drainage is given, but the worth of the book lies essentially in the applicability of the geologic picture to general earthwork practice.

Dr. Loos' booklet on a comparative study of spread and pile footings is a refreshingly frank description of the difficulties encountered in obtaining stable foundations in some of the coast cities in the Dutch East Indies. The particular value of this pamphlet lies not only in the thoroughness with which observations were made, both before and after construction, but also in the fact that such observations were made by a student of the modern science of soil mechanics.

While the paper gives a detailed account of foundation practice of apparent local interest only, the method of analysis and the completeness of data make this booklet a striking example of how foundation studies for a particular project should be, but rarely are, made.

Miscellaneous Notes on Booklets and Reprints

STRAIGHT-LINE TREATMENT of hydraulic duration curves is the subject of Bulletin No. 65, engineering experiment station series, University of Washington, Seattle, Wash. Price 25c.

PIPE FLOW BY GRAPHICAL ANALYSIS, the solution of special problems, is the subject of Bulletin No. 37, engineering and science series, Rensselaer Polytechnic Institute, Troy, N. Y. The study was made by Grant K. Palsgrove.

A CITY-COUNTRY PLAN for Covington, Ky., described in detail in a 140-page brochure by L. Segoe, consulting engineer and city planner, Cincinnati, has the unique feature of covering the city and one-third of the adjacent county. The City Planning Commission is a joint body having members from both city and county. Every feature of the plan applies with equal force in both areas, having been approved and adopted by the legislative bodies of both. It is the first plan in Kentucky that includes zoning of unincorporated areas. The improvement program and the budgeting of capital expenditures to carry out the proposals being evolved is recounted in great detail.

THE AMOUNT OF WOOD not now put to any useful purpose in New York State has been determined by a survey made for the National Committee on Wood Utilization, U. S. Department of Commerce, by a subcommittee on non-utilized wood in New York state. The commitee was made up of representatives of both private and public bodies who sought information as to better methods of utilizing the state's forest products.

LOADS ON PIPE IN WIDE DITCHES are discussed in Bulletin 108, Iowa Experiment Station, Iowa State College, Ames, Iowa. The study is the continuation of other studies carried on by the experiment station over a period of years. The first, Bulletin 31, by Anson Marston and A. O. Anderson, was published in 1913. Others are Bulletins Nos. 47, 57, 76 and 96. The present bulletin is by W. J. Schlick, drainage engineer of the station staff.

ECONOMICS OF LIGHT RAILWAYS for China are discussed by Arthur M. Shaw, consulting engineer, in booklet series No. 18 published by the Bureau of Foreign Trade, Ministry of Industry, National Government of the Republic of China. Mr. Shaw, an American engineer, has been serving as technical adviser to the national construction commission of the Chinese government for the past three years. Copies can be obtained from the Ministry of Industry, Hankow Road, Shanghai, China. Price $1.

RAIL STEEL REINFORCEMENT BARS in highway construction, the report of an investigation conducted by the division of engineering and industrial research, National Research Council, has been published as part 2 of the *Proceedings* of the 11th annual meeting of the Highway Research Board held in Washington Dec. 10-11, 1931. The findings of the committee were reported briefly in our issue of Dec. 17, 1931, p. 971. Copies of the complete proceedings may be obtained from the Highway Research Board, 2101 Constitution Ave., Washington, D. C. Price $2.

CURRENT RESEARCH IN BUILDING MATERIALS is reported by the building research board of the Department of Scientific and Industrial Research (Great Britain) in its annual statement. The report deals chiefly with the weathering of stone, research into asphalt mastics for roofing, mastic for wood-block flooring, and bituminous damp courses, cement and cast-concrete products, lime and plaster, and clay building materials. There also is a section devoted to the efficiency of buildings from the standpoint of the user. In commenting on the properties of cement the report states that the trend in recent years in cement manufacture seems to have been dominated largely by one factor—namely, that of the rate of development of strength, without sufficient consideration of other properties. Copies of the report may be obtained from His Majesty's Stationery Office, London. Price, 3 shillings net.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

RICHES FOR ALL—By Harrison E. Fryberger. Cloth; 5x8 in.; pp. 138; Published by Advance Publishing Company of New York, New York City. $1.00.

ACOUSTICS AND ARCHITECTURE—By Paul E. Sabine, Riverbank Laboratories. Cloth; 6x9 in.; pp. 327; illustrated. Published by McGraw-Hill Book Co. Inc. New York and London. $3.50.

DIE METHODE DER FESTPUNKTE—By Ernst Suter. Second edition. Cloth; 7x10 in.; pp. 340; numerous illustrations. Published by Julius Springer, Berlin, Germany. 69 RM.

TASCHENBUCH DER STADTENTWASSERUNG—By Karl Imhoff. Cloth; 5x7 in.; pp. 151; line drawings and tables. Published by R. Oldenbourg, Munchen and Berlin, Germany. 5.20 RM.

URBAN LAND USES: HARVARD CITY PLANNING STUDIES IV—By Harland Bartholomew. Cloth; 7x10 in.; pp. 174; numerous tables and diagrams. Published by the Harvard University Press, Cambridge, Mass.

DESIGN OF STEEL BUILDINGS—By Harold Dana Hauf. Cloth; 6x9 in.; pp. 222; numerous line drawings. Published by John Wiley & Sons, Inc. New York and Chapman & Hall, Ltd. London. $2.75.

VIBRATION PREVENTION IN ENGINEERING—By Arthur L. Kimball, Research Laboratory, General Electric Co. Cloth; 6x9 in.; pp. 145; line drawings. Published by John Wiley & Sons, Inc. New York City, and Chapman & Hall, Ltd. London. $2.50.

MATERIALS AND METHODS OF ARCHITECTURAL CONSTRUCTION — By Charles Merrick Gay and Harry Parker, professors of Architectural Construction, Univesity of Pennsylvania. Cloth; 6x9 in.; pp. 639; line drawings and tables. Published by John Wiley & Sons, Inc. New York City and Chapman & Hall, Ltd. London. $6.00.

REFRIGERATION—By James A. Moyer, professor of mechanical engineering, Pennsylvania State College, and Raymond U. Fittz, assistant professor of mechanical engineering, Tufts College. Cloth; 6x9 in.; pp. 538; numerous halftones and diagrams. Published by McGraw-Hill Book Co. Inc. New York and London. $5.00.

THE PORTS OF SEATTLE, TACOMA, VERETT, BELLINGHAM AND GRAYS HARBOR, WASH., Port Series No. 7 (Revised 1931)—Prepared by the Board of Engineers for Rivers and Harbors, U. S. Shipping Board. Paper; 6x9 in.; many illustrations including folding maps. Part 1, Seattle, 35c.; Part 2, Tacoma, 50c.; Part 3 Everett, Bellingham and Grays Harbor, 50c.; from the Superintendent of Documents, Washington, D. C.

THE PORTS OF OLYMPIA AND PORT ANGELES, WASHINGTON—Port Series No. 23. Prepared by The Board of Engineers for Rivers and Harbors, War Department in cooperation with the Bureau of Operations, United States Shipping Board. Paper; 6x9 in.; pp 125; maps, tables and photographic illustrations. Published by the Superintendent of Documents, Washington, D. C. 35c.

Engineering News-Record

EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, W. G. Bowman, F. W. Herring, C. S. Hill, H. W. Richardson, W. W. De Berard, N. A. Bowers, J. I. Ballard.

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R.F.C. Gains Momentum

IT IS a relief to learn from the past week's reports that the long-expected acceleration of R.F.C. construction-loan operations has come to pass, eight separate loans being approved. These loans mean work for several thousand men by Christmas, and will probably be the actual opening guns in the campaign against unemployment, since most of the projects previously approved require time to clear away legal complications, including those arising from conditions imposed by the R.F.C. Further progress is represented in the appointment of 37 regional engineering advisors, which will speed up action by clearing up points of doubt and confusion in the minds of applicants and showing them how to proceed in order to put their applications in satisfactory form most rapidly. Serious obstacles remain, however, and many of these arise from the slowness or failure of the corporation to decide legal and policy questions that are vital to applicants. An address before the construction conference at Washington last week by Harvey Couch, one of the directors of the corporation, brought to the front a number of these unsettled questions and reflected clearly the corporation's unfortunate indecision, whose effect is to check and delay applications. This effect is increased by the corporation's policy to withhold from public knowledge the record of rejected applications, for undoubtedly a general knowledge of the reasons for rejection would help other applicants to more rapid progress. Until the corporation makes definite and complete announcement of how it will apply the law's provisions the Relief Act cannot be fully effective. The present acceleration of pace within the R.F.C. lends hope that a complete policy announcement may be made soon in order to assure early recovery.

Obstacles in the Way

SOME months ago many hopeful predictions were heard that mass housing construction would lead the way out of the depression as did railroad building in the '70's and automobile and radio eleven years ago. Today the outlook ought to be much brighter, since the Relief Act made specific provision for housing loans. But the present facts are these: Real-estate interests—the more enlightened ones fortunately excepted—oppose the housing movement as jeopardizing their present investments. One state, Ohio, has succeeded in passing a housing act; the existing New York act is the only other. Not more than four or five projects have advanced to the stage where they are ready for financing, all of them in New York. Application for R.F.C. loans has been made, but the corporation has shown little sympathy for the cause. It has indicated that it is not willing to loan more than three-fifths to two-thirds of the cost, though the Relief Act says nothing about limitations of this kind and though full-cost loans have been made on bridges and waterworks. The corporation, moreover, is inclined to demand burdensome interest rates, far higher than the cost to it of the money paid by the Treasury for R.F.C. debentures. The net result is that large-scale housing construction is not likely to go ahead rapidly unless the opposing elements can be brought to see that their attitude is not only inimical to business and social progress but also is against their own best interests.

Storm Violence Appraised

QUANTITATIVE knowledge of the action of great storms is still small, and additions to it are made only at long intervals. For this very reason, however, every addition is of high value. Manuel Font's account of the Puerto Rico hurricane, the latest addition, represents an engineer's eye-witness appraisal expressed in measurable form. A significant feature of his estimates is that the value which he assigns to maximum wind force compares closely with a number of prior estimates for hurricane and tornado violence. In particular it checks the value deduced from the wrecking of the Hialeah radio towers in the Miami hurricane in 1926. All such estimates, however, must be interpreted in the light of the fact that rigid structures designed according to engineering principles have withstood hurricanes and tornados, though their ultimate strength is probably not more than half the 65 to 75 lb. per sq.ft. indicated maximum pressure. The apparent conflict of evidence is puzzling, but an explanation may be found in the effect of gusts, whose peak violence may be too short in duration to produce corresponding stress in massive structures. Under such circumstances light and non-rigid structures will suffer damage proportional to the peak intensity, while heavy and rigid structures survive. At best this inference is tentative, however. Much more extended observation supplemented by experimental study of the phenomena involved is necessary before the question can rest on a satisfactory basis.

New Evidence

WHEN the failure of the Alexander Dam by a great mud outflow three years ago added a sensational new happening to the record of hydraulic-fill accidents, it was thought by many that the peculiar nature of the fine-grained earth used for the dam was the critical factor. There were those who doubted whether a dam could be built safely of this material by the hydraulic process. But the engineer in charge, J. B. Cox, was convinced that the break-out would not have occurred but for obstructed drainage of the beach material that formed the retaining bank. He remained confident in the suitability of the local soil, and saw definite confirmation of his beliefs in the resistance of the core and the upstream bank, pointed out in our report of the failure (*ENR*, May 22, 1930). Accordingly he set about rebuilding the dam with no change in material or method except that of giving more careful attention to bank drainage. Successful completion of the dam, which we report this week, constitutes a noteworthy justification of the engineer's judgment. The facts as they now appear suggest that undue attention has been given in the past to the core, and not enough attention to the beaches or banks. According to the experiences of the past few years, banks of adequate stability as to section and material, thoroughly drained to prevent ac-

cumulation of water coming from their own mass or from the core, are the primary considerations in building hydraulic-fill dams.

Great Power Plants

THE EARLY days of October saw the start of operation of a hydro-electric power plant on the St. Lawrence River at Beauharnois, Quebec, and the formal dedication of another on the Dnieper River in Russia. Both are destined to be great plants, ultimately surpassing any yet built in the installed capacity of their generating equipment. The present installation in the Beauharnois plant, however, is only 216,000 hp., though its ultimate capacity will be 2,000,000 hp.; the machinery now under contract for the Dnieprostroy plant will have a capacity of 500,000 hp., though the ultimate installation will be 765,000 hp. Thus neither plant yet exceeds the 570,000-hp. Queenston plant below Niagara Falls, still the world's greatest hydro-electric station. Nevertheless, both the Dnieprostroy and the Beauharnois plants are notable as marking definite progress toward development of the relatively few very great water-power sites in the world, sites which by their very magnitude heretofore have kept men from attempting to harness them. This is especially true of Beauharnois, where a construction plan has been worked out which permits of a relatively small, yet economically justifiable, installation at the start without sacrifice of the larger economies that should come with full utilization of the site. Progressive development of this kind is one of the greatest problems of the hydraulic engineer.

Bridges Go West

AFTER three years during which no bridge construction of any note was recorded another bridge-building period, perhaps rivaling that of the latter 1920's, is about to begin. The scene this time is laid on the West Coast, entirely new territory for large bridges; for, with the exception of the St. Johns bridge in Portland, Ore., no structure of more than 1,000 ft. exists west of Detroit. The long-delayed Golden Gate Bridge, upon which bids were received last week, will have a main span of 4,200 ft. which is 700 ft. longer than the Hudson River bridge at New York. The Bay Bridge, connecting San Francisco and Oakland, upon which first bids will be asked within 60 days, contains two suspension bridges end to end, whose two main spans of 2,310 ft. each take precedence over all except the New York structure and their San Francisco contemporary.

Preoccupation with the difficulties of financing and with the potential employment involved in their construction has overshadowed to a large extent an appreciation of the magnitude and technical significance of these great structures. Foundation problems of unparalleled difficulty must be met on both bridges, at the Bay Bridge particularly. The central anchorage, founded on rock 180 ft. below water level, is a block of concrete 97x192 ft. in plan with a volume of about 180,000 cu.yd. Thus the San Francisco bridges will make foundation history. The design problems of the superstructure, on the other hand, have been solved largely on previous bridges, notably the Philadelphia-Camden and Hudson River structures. However, the multiple-span studies for the Bay Bridge stand as an important addition to bridge design knowledge. And, finally, the 1,400-ft. cantilever span which forms the east channel crossing of the Bay Bridge is a notable structure in its own right, being exceeded in length by only two bridges in the world, the St. Lawrence Bridge at Quebec and the Firth of Forth Bridge in Scotland.

The significance of the San Francisco bridges does not end with their technical merits. Closing age-old gaps in transportation routes that each year have seen more people dependent upon them, they will bring into necessary unity a region whose interests are inseparably bound together. The bridges also, we hope, are symbols of a returning spirit of enterprise that has recently been sorely absent.

Construction Advances

THREE MEETINGS of construction groups at Washington last week formed an occasion of quite exceptional significance. Occurring at a time when every unit of professional and industrial activity in the field of construction is subject to abnormal stress and must adjust itself to new and severe conditions, the meetings of the Associated General Contractors, the Construction League and the National Conference on Construction in their joint effect achieved the result of outlining in clear perspective for the first time the principal components of the construction field, its industrial structure and the difficulties that retard its progress. This essential preliminary to effective unification of the field represents a solid and lasting achievement. The groundwork has been laid for advance.

Particular mention is due the National Conference on Construction. Conferences usually prove so empty of accomplishment that what the Construction Conference did was a gratifying surprise. Its committee studies will be of permanent value. Together with the A.G.C. and Construction League meetings the Conference brought to view very clearly the existence of many serious faults, conflicts and misadjustments both within the construction circle and in the relations of construction to realty, finance and public affairs.

Consideration of problems of these two kinds convinced all that for the present they require separate discussion. Problems internal to the industry are most effectively discussed in a forum in which direct construction interests only are represented, while problems of external relations require a forum of other kind. It was not least of the accomplishments of the group of construction meetings that the Construction League was recognized as the appropriate place for discussion of problems arising within the industry. External relations will be handled temporarily by a continuing organization based on the conference, leaving the ultimate solution to be developed later.

This assignment of the task of caring for internal problems to the Construction League will have general approval. The difficulty of the problems concerned has been greatly emphasized by the events of the last few years, and indeed some of them have for the first time come into close view. It is now recognized by leaders of professional, contracting and industrial elements of the industry that correction of faulty interrelationships and unsound practices is essential to the future well-being of construction. The weight of the responsibility laid on the youthful League is correspondingly great, and places upon it the burden of developing its organization and procedure adequately to meet the responsibility.

NEWS OF THE WEEK

Chicago Diversion Case Revived

Upon request of the states of Ohio, Wisconsin, Minnesota and Michigan, the U. S. Supreme Court has called upon the state of Illinois and the Sanitary District of Chicago to show cause on or before Nov. 7 why they have not taken appropriate steps to comply with the requirements for reduction of the diversion water from Lake Michigan laid down by the court in 1930. The answer of the state of Illinois is to be heard by the court on Nov. 14.

Unusual Accident Injures Men in Owens River Aqueduct

Fifteen workmen engaged in cleaning and painting the interior of the Grapevine siphon on the Owens River aqueduct 150 miles north of Los Angeles were injured on Oct. 13 when they fell about 800 ft. down the interior of the siphon. One man entering the siphon for the midnight shift lost his footing and in falling down the slope struck other men at work below him causing the whole group to fall down the 25-deg. slope to the bottom of the siphon. A number of the injured suffered broken bones and all were cut and bruised but none was fatally injured.

First Colorado Aqueduct Bids Will Be Called Soon

Regardless of the suit pending in the Federal court of the District of Columbia to hold up R.F.C. financing for the Colorado River aqueduct of the Metropolitan Water District of Southern California the district is planning to call bids on the first units of the project, bids to be opened Nov. 29. This first call will be for bids for the 13-mile San Jacinto tunnel and for a power line from Colton for tunnel construction work. Letting of contracts for this work, of course, will depend upon the outcome of the suit. District officials hope to have the suit thrown out.

Meantime, other steps have been taken to expedite the beginning of actual construction. A wage scale has been adopted by the district for the work and the board has authorized the call for bids on the bonds although the call will not be made until the suit and all other controversial matters are settled. With the assurance of an R.F.C. bid on the bonds, up to $40,000,000 which is enough to carry construction work for two years, the district can have money available for the first units within six weeks after the suit is settled.

At the time the bids for the tunnel are opened the district board of directors will call for a recommendation from Frank E. Weymouth, general manager. Thereafter, it will be decided whether the work is to be done by the lowest responsible bidder or is to be done directly by the district under force account.

Under terms of the specifications, materials, such as cement and steel, to be used in the tunnel will be provided by the district, and so these materials are not included in the specifications.

Water Supply Works In Several Cities Get R.F.C. Money

LOANS for eight self-liquidating projects totaling $2,979,000 were approved by the Reconstructon Finance Corp. at its meeting held on Oct. 12. The work included is chiefly for the expansion of water supply systems.

The largest loan authorized was to the city of Seattle, Wash. The R.F.C. directors have agreed to purchase $1,491,000 of revenue bonds of the city to provide money for replacement of inadequate water mains, the laying of new mains, repairs to an existing reservoir and construction of an additional reservoir. The pipe requirements of the city include cast iron, steel, concrete and wood-stave pipe. The largest diameters are 78-in., both steel and concrete.

The sum of $580,000 is to be supplied to the city of Wilmette, Ill., through the purchase of 5 per cent water revenue bonds. About $237,000 will be used for the construction of buildings, $119,000 for piping and filter equipment, and $124,000 for pumping equipment, for an intake and a standby generator. Bids will be opened Nov. 15. The plans and specifications are essentially those on which bids were received April 5 but rejected because of inability to sell bonds.

Sandusky, Ohio, gets $77,000 to construct a sludge basin for its water purification plant.

Expansion of the waterworks and sewerage system of Roanoke Rapids, N. C., is to be made possible by the agreement of the R.F.C. to purchase $365,000 of bonds of the Roanoke Rapids Sanitary District.

A loan of $200,000, subject to the city passing a bond ordinance, was authorized for Conneaut, Ohio, to be used to construct a new water supply intake from Lake Erie, a filtration and pumping plant and reinforcement of the water distributing system. The principal of the loan is to be repaid at the rate of $10,000 a year for 20 years from 1933 to 1952, inclusive.

Columbia, Ky., is to obtain a loan of $29,000 for the completion of its water supply system and Maysville, Ky., is to obtain a loan of $47,000 for the construction of a filtration plant.

Toll bridge work

Completion of the toll bridge between Savannah, Ill., and Sabula, Iowa, has been made possible by a loan of $190,000 to the Savannah-Sabula Bridge Co. All foundations and piers, concrete approaches and about 45 per cent of the steel work on the bridge had been completed when the work was stopped several months ago due to shortage of funds. The Bridge Co. gave three-year notes secured by a pledge of the bonds of the company.

Application of the Chesapeake Bay Bridge Co., Baltimore, for a loan of $7,500,000 for the construction of a 6¼-mile long bridge across Chesapeake Bay has been modified by reducing the amount to $6,250,000. The company agrees to contribute $1,250,000 represented by securities junior to the security offered the R.F.C.

York River bridge authorized

The York River Bridge Corp., of Newport News, Va., has received authority from the state highway commission to construct a toll bridge over the York River between Yorktown and Gloucester Point. The Independent Bridge Corp. of Richmond sought permission to build a bridge at this site and also a bridge at Jamestown. The York River Bridge Corp. plans to apply to the R.F.C. for a loan of $1,500,000 to finance the bridge, the bridge to be turned over to the state as a free bridge as soon as the loan is amortized.

Construction of a bridge across the Potomac River from Morgantown, Md., to Dahlgren, Va., at a cost of $3,000,000 with R.F.C. is under consideration.

The recommendation that New York City apply to the R.F.C. for a loan for the completion of the Triborough Bridge has been put off for consideration by the Board of Estimate until early in November.

Sanford, N. C., has applied to the R.F.C. for a loan of $45,000 for the construction of a dam on Partridge Creek and for building a filtration plant.

Pumping plant proposed

Chicago plans to ask the R.F.C. for a loan of $4,000,000 for the construction of a new pumping station to replace three old stations. Handsome savings are anticipated. Collateral would be water certificates to be serviced from water revenue only.

The request of the lighting department of the city of Seattle for funds for use in the completion of its Skagit River work has been reduced from $7,500,000 to $3,500,000.

The board of supervisors of Amherst County, Va., seek a loan of $62,500 from the R.F.C. for a waterworks system in Madison Heights, a suburb of Lynchburg.

Youngstown, Ohio, is preparing to apply for a loan of $400,000 for the construction of a municipal power plant.

Application for a loan of $175,000 for the completion of the county and city office building at Mt. Clemens, Mich., is to be made to the R.F.C. by the board of supervisors of Macomb County.

Housing project at St. Louis

Plans for the rehabilitation of the district bounded by Jefferson and Tass Aves., Choteau Ave. and the Mississippi River are under consideration by the Neighborhood Associaton there. Clearing out of old houses and the construction of new housing for rental at low rates is proposed. The work is estimated to cost $1,300,000, $300,000 to be raised by public subscription and $1,000,000 obtained from the R.F.C. under the provisions for financing limited dividend corporations.

Application for a loan of $1,600,000 from the R.F.C. for the construction of the Western Railroad approach to the Municipal Bridge across the Mississippi River at St. Louis is proposed as soon as the details

(Continued on p. 482)

Quick Legislation Expected on San Francisco-Oakland Bridge

The contract covering maintenance and operation of the San Francisco-Oakland Bridge which must be ratified by the state of California before the R.F.C. loan can be available awaits the action of the next session of the California Legislature. Because the Legislature meets in regular session on Jan. 2 next it is not expected that a special session prior to that date will be called.

Advertising for substructure bids, the first main construction item, will require 60 days. Thus it is not expected that actual construction can begin until early next year. However, with effective preparations meantime and by making this a special order of business immediately the Legislature convenes it is expected that work on a large scale can be under way by early in the spring.

Power Commission Reasserts Control Over New River Work

As a step in the determination of whether the Federal Power Commission has the right to take control over the projected development of the Appalachian Electric Power Co. on the New River in Virginia, the commission, on Oct. 12, formally adopted a resolution in which it declared "that New River, from the mouth of Wilson's Creek, Va., north is navigable water within the definition thereof, as set forth in section 3 of the Federal Water Power Act."

Attempts are expected to be made to have the Supreme Court determine the extent of the power commission's authority over parts of rivers which while not navigable in fact yet may be said to have an effect upon the navigation of lower reaches of the same river or of other streams. As in the case of the proposed development of the Appalachian Electric Power Co., the matter of whether state public utility commissions or the Federal Power Commission shall take jurisdiction hangs on this point.

Contractor Loses Suit Over Caisson at Poughkeepsie

DECIDING against the contractor and in favor of New York state, the court of claims at Albany on Sept. 20 adjudicated the contractor's claim arising from the tipping of the east pier caisson of the Mid-Hudson Bridge at Poughkeepsie on July 27, 1927, and the subsequent work in righting the caisson, which extended over more than a year. Blakeslee Rollins Corp., the contractor, sued for $365,250, which (aside from a few small balances) was claimed as the extra cost arising from the listing and the work necessary to bring the caisson back to a vertical position and complete its sinking. The contractor alleged that the caisson was topheavy in design. The state claimed that the caisson was properly designed and that the listing was due to the contractor's action in excavating to an excessive amount under one side of the caisson. The circumstances of the accident and the recovery operations were reviewed in detail in *Engineering News-Record* of Feb. 12, 1931, p. 275.

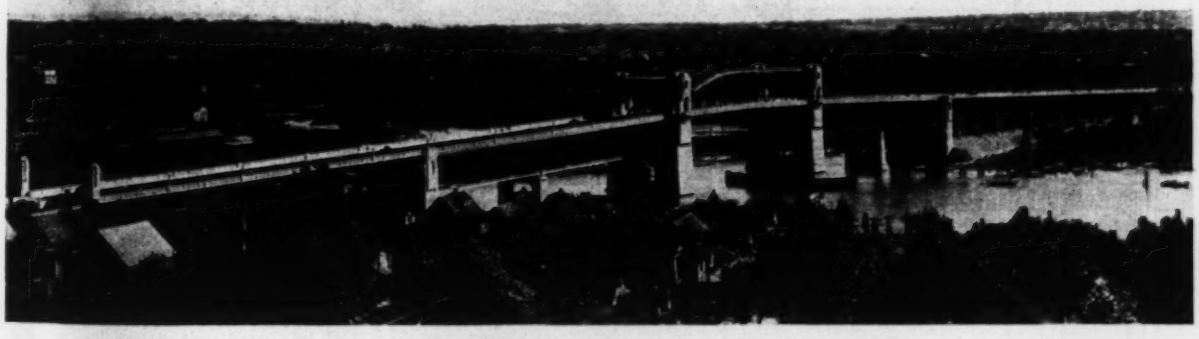
The caisson was a steel and reinforced-concrete structure 60x136 ft. in ground plan area and contained 25 dredging wells, which were temporarily closed for flotation by false bottoms built of 12x14 in. timbers. The caisson after launching and building up was brought to the pier site, where the water was about 55 ft. deep, and was sunk to the river bottom on June 7, 1927. During the following six weeks the removal of the false bottoms and the beginning of dredging through the wells was in progress. The bottoms proved difficult to remove, and more were removed along the east side and longitudinal center line of the caisson than along the west side. The contractor began dredging, however, chiefly along the east side and center, reaching depths up to 15 ft. below cutting edge, and also dredged a trench 9 ft. deep and 60 ft. long adjacent to the east side of the caisson. By July 26 some 13 or 14 bottoms had been removed and the caisson cutting edge had gone down to 11 ft. below river bottom. In the night of July 26 to July 27, following several hours of active dredging, the caisson suddenly tipped over eastward to an inclination of about 45 degrees. It was not righted until more than a year later.

In its findings the court of claims says that the caisson was stable when floating, was stable when it landed at the bottom of the river, and was sufficiently stable to penetrate into it for 11 ft. without accident, and that it was properly designed and capable of being sunk to accomplish the purpose for which designed. It found that "the caisson listed because there was a hole dug under one side of it and the caisson fell into the hole," and that this was due to the contractor's negligence and his unskillful and unworkmanlike operation. It declared that "the work and expense involved in the erection of the caisson, after the tipping, to vertical position in the river and sinking it to the proper elevation was the responsibility of the contractor in fulfillment of its contract to erect said caisson, and there should be no recovery for this."

J. L. Schley Named Governor of Panama Canal Zone

Julian L. Schley, engineer of maintenance of the Panama Canal, was appointed to be governor of the Canal Zone by President Hoover on Oct. 13. Colonel Schley succeeds Col. Harry Burgess whose term of duty as governor is up this month.

Colonel Schley graduated from West Point in the class of 1903 and subsequently took post-graduate work in engineering at the engineer school, Washington Barracks. From 1913 to 1916 he served as executive officer of the public utilities commission of the District of Columbia. During the World War he commanded the 307th Engineers in France. After service with the War Claims Board he was district engineer at Nashville and at Galveston and assistant commander at the engineer school at Ft. Humphrey, Va. He was appointed engineer of maintenance, Panama Canal, in 1928.



MONUMENTAL BRIDGE COMPLETED IN VANCOUVER, B. C.

The Burrard St. Bridge, connecting two sections of the city of Vancouver, B. C., was recently completed at a cost of $1,739,000. It is 2,817 ft. long between abutments and the design includes provision for a future double-track railway deck at a lower level. Four steel deck-truss spans and a high-level through-truss span are used to effect the river crossing. The approaches at either end are concrete viaduct. A 60-ft. roadway is provided. The bridge incorporates a number of decorative features, the outstanding of which are monumental boat figureheads in the galleries over the roadway on either side of the main span and the coat of arms of Vancouver placed over the portals. Hodgson, King & Marble and Dawson, Wade & Co., Ltd., Vancouver, had the contract for the bridge. J. R. Grant was consulting engineer.

Company Formed to Build Connection to Moffat Tunnel

A new company to be known as the Denver, Salt Lake & Western Railroad Co. has been organized as a subsidiary of the Denver, Rio Grande & Western R.R. to construct the Dotsero cutoff connecting the Denver & Rio Grande with the Denver & Salt Lake west of the Moffat tunnel. Recently a loan from the R.F.C. was authorized for the construction of this cutoff. Award of the contract for the work is reported unofficially to have been made to a combination of Utah Construction Co., W. A. Bechtel Co., and Morrison-Knudsen Co.

Holders of the supplemental bonds issued by the Moffat Tunnel Improvement District for the completion of Moffat tunnel after the original bond issue had been found inadequate to cover the cost of construction won another skirmish in their fight to establish the validity of the bonds when the United States Supreme Court refused to consider an appeal from the decision of the U. S. Circuit Court of Appeals for the Tenth Circuit upholding their validity. Validity of the bonds has not yet, however, been definitely established as the taxpayers' suit is now before the Colorado Supreme Court.

R.F.C. Loans

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can be worked out. The cost will be paid through tolls charged the railroad.

Construction of a public market at a cost of $1,500,000 is proposed by the city of Portland, Ore. Application has been made to the R.F.C. for money to cover part of the cost of the project. Contract for the work has been let.

Construction of a municipal power plant by the city of Salem, Ohio, with R.F.C. money is being considered by the city council.

Irrigation in Washington

The Yakima-Benton Irrigation District of Yakima, Wash., has applied to the R.F.C. for a loan of $12,000,000 for the development of a 72,000-acre project lying between Yakima and Prosser.

At Seattle, the port commission plans to ask a loan of from $2,500,000 to $3,000,000 for the construction of a new terminal to provide facilities for the inter-coastal service of the Grace Lines between Seattle and New York, the loan to be repaid through port revenues.

Causeway in Florida proposed

The Overseas Bridge Corp., Miami, Fla., has made application to the R.F.C. for a loan of $10,750,000 for the construction of 13.2 miles of bridges and 13.4 miles of causeway and fill between Lower Matecumbe and No Name Keys on the Overseas highway to Key West.

Construction of a women's dormitory at the University of Colorado to cost $550,000 is proposed in a loan application being made by the university to the R.F.C.

Quincy, Ill., plans to apply to the R.F.C. for a loan of $100,000 for the construction of a terminal for river barges, and East St. Louis, Ill., has voted to apply for a loan of $500,000 for city park improvements.

Engineers Named To Aid Applicants For R.F.C. Loans

THIRTY-SEVEN well-known engineers have been asked by the Reconstruction Finance Corp. to act as advisers to its local loan agencies in the consideration of self-liquidating projects for which loans are asked. The corporation expects that applications for loans, especially the smaller loans, will come first to its local agencies in the larger centers throughout the country. By providing each agency with engineering advisers it hopes not only to speed up the completion of the applications, but also to save the applicants the expense of travel involved in having the engineering features of their applications first reviewed by the corporation's engineering staff in Washington.

Engineering work not involved

Engineering work such as the preparation of plans and estimates is not expected of these engineers nor is the idea of the corporation that they will eliminate other engineering services. Rather, it is the opinion of the directors of the corporation that by having these engineering advisers on the staff of their local agencies the need for adequate engineering work can be impressed upon the applicants who might otherwise send through applications to Washington with incomplete supporting data of an engineering nature.

The engineers invited by Harvey Couch, director of the Reconstruction Finance Corp., to serve, together with the agencies to which assigned is as follows:

NAME	LOAN AGENCY
McDonald, F. H.	Atlanta
Thurlow, Oscar G.	Birmingham
Lee, William S.	Charlotte
Hammond, Alonzo J.	Chicago
Sando, Will J.	Chicago
Hawley, John B.	Dallas
Noyes, Edward N.	Dallas
Crocker, Herbert S.	Denver
Hubbell, Clarence W.	Detroit
Hallihan, J. P.	Detroit
Thompson, Francis A.	Helena
Cummins, Robert J.	Houston
Youngberg, Gilbert A.	Jacksonville
Stayton, Edward M.	Kansas City
MacCrea, Don A.	Little Rock
Bent, Arthur S.	Los Angeles
Cory, H. T.	Los Angeles
Brigman, Bennett M.	Louisville
Shenehon, Francis C.	Minneapolis
Wheeler, Walter H.	Minneapolis
Dyer, Arthur J.	Nashville
Hogan, John P.	New York
Fuller, George W.	New York
Blossom, Francis	New York
Adams, Everett E.	Omaha
Mickey, C. E.	Omaha
Follin, James W.	Philadelphia
Fernald, R. H.	Philadelphia
Henny, D. C.	Portland
Saville, Allen J.	Richmond
Beers, W. D.	Salt Lake City
Galloway, John D.	San Francisco
Huber, Walter LeRoy	San Francisco
Shannon, W. D.	Seattle
Jacobs, Joseph	Seattle
Fisken, John B.	Spokane
Brown, Baxter L.	St. Louis

Two engineers have been named to assist most of the larger agencies, and at New York three have been asked to serve.

Mr. Couch, in his letter to the engineers, said that the R.F.C. engineering board hoped to benefit from the reactions of engineers well acquainted with the local projects.

No compensation except remuneration for travel is involved.

Water Supply from Trinity River Proposed for Houston, Texas

A proposal to supply the city of Houston, Texas, with 130 million gallons of water per day, approximately four times the present output of the city's well supply, has been made to the city by the Barbers Hill Canal Co. The company holds rights to draw 170 million gallons per day from the Trinity River. Part of this water is used for irrigation purposes and the company believes that by extending its canal system to within 16 miles of the city it could use its surplus for supplying the city. The cost of the necessary dam for impounding the water, pipe lines and filtration plant is estimated at from $2,000,000 to $2,500,000.

New San Gabriel Bids to be More Detailed on Quarrying

The new, and third, specifications for quarrying the rock-fill material for San Gabriel dam No. 1 of the Los Angeles County Flood Control District will be more detailed as to quarry operations and the factor of transportation. The new specifications will tend to remove a considerable part of the contractor's risk involved on this job.

Original specifications called for a unit figure for rock placed in the dam only, leaving bidders entirely free as to quarry selection and operation. The single proposal called for the handling of the entire project and only one bid was received which was considerably above the engineer's estimate. This bid was rejected. A second call for bids provided separate contracts for features of the work, other than the rockfill. Specifications for quarrying were not changed. The lowest combination of bids was still well above the engineer's estimate and only one bid was received for quarrying and placing which represents about 80 per cent of the total cost. These bids were also rejected.

The new specifications will designate a number of quarry locations in the canyon with estimates of available rock, stripping and waste. The nearest quarry will be taken as a base and a definite distance from quarry to site established. Bidders will be asked for unit prices from this quarry as follows:

1. Yards of rock accepted and placed directly in dam.
2. Yards of rock passed over a grizzly prior to placing in the dam and measured in place in the dam.
3. Yards of stripping as measured by cross sectioning.
4. Yards of waste which shall be defined as rejects at the quarry (other than stripping) and material passing through the grizzly.

The purpose of the grizzly, which is to be located on the road between quarry and site, is to provide for better classification than can be done by the shovels in the pit. The grizzly will only be used when conditions in the quarry indicate that the quarry run contains unacceptable material.

In addition to unit prices for the base quarry, bids will be asked for other quarry sites on the basis of additional price per yard above the base quarry figure. These bids will include only rock placed in the dam, the prices for stripping and waste are considered to be the same. Alternate proposals will be called for again.

Bill for Sewer Service Charges Introduced in Illinois

To make it possible to obtain funds for sewerage construction, a bill has been introduced into the Illinois state legislature. It provides authority to borrow from the R.F.C. funds for construction, the bond interest and amortization to be cared for by service charges only. The property of the sewerage system is mortgaged and in case of default a receiver may be appointed with power to charge and collect rates sufficient to service the bonds and operate the plant.

The bill was drawn in conformity with the suggestion of the National Committee on Trade Recovery.

Wage Rates Set for Work on Los Angeles Aqueduct

Adoption of a wage scale in accordance with the California prevailing-wage law, and authorization of the issuance of the first block of bonds for the construction of the proposed Colorado River aqueduct, was voted by directors of the Metropolitan Water District of Southern California Sept. 30. The amount of the bonds to be issued is $2,016,000, which is considered sufficient to get the work under way. In addition to the wage scale, the district directors will establish a rate for board and housing construction forces. A rate of $1.40 per day will be charged each man for three meals. Housing probably will be recommended. The Hoover Dam board and housing rate was quoted in discussion of the directors as $1.60 per day.

The matter of staggering the employment schedule so as to give work to the greatest number of men possible also was discussed by the district board, the directors expressing their desire to do so, but at the same time recognizing practical obstacles that must be overcome, such as the nature and remoteness of much of the work.

The wage scale, based on an eight-hour day, with no extra pay for Sunday or holiday work, follows:

Classification	Per Diem Wage
Blacksmith	$6.00
Carpenter	6.00
Carpenter, form work	5.60
Compressorman	5.00
Concrete equipment operator	5.20
Concrete finisher	5.60
Dragline or shovel operator	9.00
Dragline or shovel operator assistant	5.20
Driller, jack hammer man	5.00
Electrician, lineman	7.20
Fence erector, steel	5.60
Graderman, road machine operator	5.60
Hoistman, derrickman, crane operator	6.00
Laborer	3.80
Lather	6.00
Mason	7.20
Mechanic, repairman, pipeman	6.00
Miner, machineman	5.60
Miner, chuck tender	5.20
Motorman	5.20
Mucking machine operator	8.00
Painter	6.00
Plasterer	7.20
Plumber	7.20
Powderman	6.00
Roofer	6.00
Sheet metal worker	7.20
Steam fitter	7.20
Steel worker, reinforcing steel	5.20
Tile setter	7.20
Timber framer	5.60
Tractor driver	5.00
Trench machine operator	6.00
Truck driver	5.00
Welder	7.20
Well driller	7.20
Any classification omitted herein not less than	3.20

San Francisco Garbage Plans Again Put Up to Voters

Again the citizens of San Francisco will be asked to decide the merits of alternate plans for garbage disposal when three proposals appear on the November ballot. The board of supervisors has voted to seek a decision on the following:

1. Award to most satisfactory bidder a franchise for disposal of garbage by incineration or other method except sea dumping.
2. Award to lowest bidder a franchise for collecting garbage, with provision that high bid shall not exceed present rate.
3. Award to most acceptable bidder the franchise for combined collection and disposal, other than sea dumping.

The injunction which has been pending for 3½ years against operation of the old Thackeray destructor in San Francisco was brought to life on Oct. 10. On that date Judge Mogan, of the San Francisco Superior Court, made the injunction effective ten days from date or Oct. 20, 1932. This injunction is the outcome of a suit that was begun by protestants in the neighborhood of the destructor in 1926, the claim being that the smoke, odors and debris incidental to its operation constituted a public nuisance.

The old destructor has been in service for some 30 years and recently has been carrying an extremely heavy overload, San Francisco's garbage is now averaging about 650 tons daily (the seasonal range being from 600 to 710 tons with an average 3 per cent annual increase). Brief review of the garbage disposal situation at that time appeared in *Engineering News-Record*, Nov. 14, 1929, p. 786.

San Francisco's chief administrative officer, A. J. Cleary, has announced that when the destructor is closed down disposal will be by the fill-and-cover method as a temporary expedient. The fill will be made outside the city limits along the Southern Pacific Railroad whose cars will convey the garbage to the point of disposal.

There is a city ordinance in San Francisco limiting to $1 per ton the amount that can be paid by the city for disposal.

Ban on Outside Contractors Removed by Maryland

Limitations set by the Maryland State Roads Commission requiring that bidders on certain projects of the commission be Maryland contractors have been removed by the commission. The part of the commission's order that required that only labor from Maryland be employed in all but supervisory capacities has been retained, however.

Hoover Dam Notes

Excavation in the open cut for the outlet structure of diversion tunnel No. 4 has been completed. Stripping in the section above the locations of outlet works and adit portal has been practically finished and adit portal excavation started. At the upstream cofferdam, excavation for the percolation stops was completed for the Nevada side and has been started for the Arizona side. Operation at the Arizona deposit has been suspended for an indefinite period in order to use the 5-yd. dragline and railroad equipment for construction of the cofferdams. The screening plant will secure its supply from raw storage.

Designs are being prepared for a cement blending plant for the mass concrete of the dam, some revisions have been made in the construction drawings for the coffer dams, the preparation of alternate plans for the foundation and abutments of the dam is in progress and final designs for the 150-ton permanent cableway house, to be located on the Nevada side, are being prepared. Pencil drawings of the electrical installation for the 50 ft. x 35 ft. Stoney gate structure on the Arizona side have been completed. The draft of the turbine specifications for the power plant was forwarded to Los Angeles for review by the electrical engineer and representatives of the Southern California Edison Co. and the City of Los Angeles.

1,500-TON BULKHEAD GATE FOR HOOVER DAM TUNNEL

The first of two 50x50-ft. bulkhead gates, each weighing 1,500 tons, that eventually will seal the intakes of the outer diversion tunnels at Hoover dam has just been fabricated in the plant of the Consolidated Steel Co. at Los Angeles. The gate will be knocked down for its trip to the dam. About 40 flat cars will be required.

Work Expected to Re-start on Abitibi Canyon Project

Work on the hydro-electric power project in the Abitibi River canyon in northern Ontario which was stopped last summer because of the inability of the Ontario Power Service Corp. to meet bond interest is expected to be resumed soon. On Oct. 11 the cabinet of the Province of Ontario ratified the proposal to have the province purchase the development through an exchange of bonds of the Ontario Hydro-Electric Power Commission and the bonds of the Ontario Power Service Corp. Ratification of the agreement will permit the work to be carried forward by the power commission.

SOCIETY CALENDAR

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual meeting, Washington, D. C., Nov. 14-18.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, annual meeting, Pittsburgh, Pa., Oct. 20-21.

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, Washington, D. C., Oct. 24-27.

AMERICAN SOCIETY OF MUNICIPAL ENGINEERS, annual meeting, Detroit, Mich., Jan. 16-20.

ASPHALT INSTITUTE, Asphalt Paving Conference, New Orleans, La., Dec. 5-9.

HIGHWAY RESEARCH BOARD, National Research Council, Washington, D. C., Dec. 1-2.

HIGHWAY AND BUILDING CONGRESS participated in by fourteen national engineering societies and trade associations, Detroit, Mich., Jan. 16-20.

INTERNATIONAL CITY MANAGERS ASSOCIATION and GOVERNMENTAL RESEARCH ASSOCIATION will hold a joint annual conference at Cincinnati, Ohio, on October 24 to 26.

NATIONAL ASSOCIATION OF RAILROAD AND UTILITIES COMMISSIONERS, annual meeting, Hot Springs, Ark., Nov. 15-18.

OHIO CONFERENCE ON WATER PURIFICATION, at its annual meeting held at Warren, Ohio, Oct. 11-12 elected Thomas Tristram chairman for the coming year.

TEXAS PUBLIC HEALTH ASSOCIATION will hold its 10th annual short school for laboratory men at Dallas, Texas, Nov. 7-8. General sessions will be held Nov. 9-11.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold a district meeting at New York Nov. 17 which will be a symposium on timber as an engineering material.

PACIFIC SOUTHWEST SECTION, Society for Promotion of Engineering Education, will hold its first annual meeting at the California Institute of Technology Dec. 29-31.

WISCONSIN SECTION, American Waterworks Association, met Oct. 11-12 at Appleton with the West Shore Water Producers Association as guests. Discussions included the following topics: proposed relation of sewer rental law to waterworks, economical replacement of pumping equipment, federal relief and unemployment construction, shut-off policy, water rates and construction, water purification, softening, main sterilization, two-main systems, service pipe experiments, underground water, elevated tanks and paint.

ROCKY MOUNTAIN SECTION, American Water Works Association, will hold its annual meeting and exhibit in Denver, Oct. 24-26. Subjects scheduled include the following: Economics, rate structures, effect of metering on revenue, rebating water bills, R.F.C. loans; purification, algae determination and control, laboratory examinations, ammonia-chlorine and activated carbon experience, filter sands. The convention will be run in conjunction with and as a waterworks college of the bureau of business and government research of the University of Colorado. Full attendance entitles the delegate to a "certificate" from the university.

Golden Gate Bridge Low Bids

Low bids for the construction of the Golden Gate suspension bridge at San Francisco, opened Oct. 14, total $23,844,000, as compared with a low total of $24,304,000 of bids submitted last year. The former low bid of the McClintic-Marshall Corp., $10,494,000, for the erection of the superstructure steel, was allowed to stand and this portion of the work was not readvertised. The low bids submitted for the readvertised portions are as follows: Contract 1-B, cables, John A. Roebling's Sons Co., $5,855,000; contract 2, main piers, Pacific Bridge Co., $2,935,000; contract 3, anchorages and approach piers, Bridge Builders, Inc., $1,859,854; contract 4, steel for San Francisco approach, Bridge Builders, Inc., $934,800; contract 5, Presidio road, Bridge Builders, Inc., $996,000; contract 6, Sausalito road, Chegris & Sutsos, $59,780; contract 7, roadway slabs on main span, Clinton Const. Co., $555,000; contract 8, electrical installation, Alta Electrical & Mechanical Co., $154,470.

These bids include cost of cement. Last year the bids were based on furnishing of cement by the Golden Gate Bridge and Highway District.

Investment Rating of Buildings Proposed by Engineers

Holding that the public has suffered enormous losses due to irresponsible promotion, inflated valuation and because of improper designs, faulty and fraudulent construction and incompetent inspection, also that the investing public should be able at all times to obtain trustworthy information on the condition of a building offered as security, the Western Society of Engineers has recommended that all investment projects should be classified as to structural safety, efficiency of operation and economy of maintenance. To this end a "certificate of rating" by competent experts is suggested. Further the society pledges itself to cooperate with other interested organizations in promoting the general adoption of such a proceeding and in the development of adequate standard specifications for classifying buildings and other projects.

This action was taken following a report by a committee consisting of Chester B. Burdick, chairman, Frank D. Chase, H. H. Hadsall, W. O. Kurtz, Edgar Martin and C. L. Post.

Cameron County, Texas, Plans To Construct Irrigation Works

A suit to validate the organization of a Cameron County Water Improvement District No. 19 (Texas) and to establish the legality of its bonds totalling $950,000 has been filed by the district in the District Court at Austin, Texas. An order to issue the bonds was approved at a recent meeting of the directors of the district and an effort is being made to arrange for their sale through the Reconstruction Finance Corp.

The sale of $541,000 of bonds of the Orange County (Texas) Conservation and Reclamation Board has been approved by the attorney-general of the state. The bonds are for drainage work.

Work Starts on Ten Buildings for Chicago World's Fair

Work has been begun on ten additional units for the Century of Progress Exposition to be held in Chicago next year. The total value of these buildings is close to two million dollars, nearly half of which is the cost of the "Sky Ride" with its two 625-ft. towers. The total cost of all construction now under way is about $4,000,000.

Personal Notes

ONWARD BATES and CHARLES L. STROBEL recently were made honorary members of the Chicago Engineers Club at a luncheon given in their honor.

C. F. LAMBERT of the Burns & McDonnell Engineering Co. has been placed in charge of the new office of that company which has been opened in Cincinnati, Ohio.

EUGENE REYBOLD, major, Corps of Engineers, district engineer at Buffalo, N. Y., is to be transferred to Washington for duty with the Board of Engineers for Rivers and Harbors about Nov. 1.

WILLIS E. TEALE, major, Corps of Engineers, who has been serving with the American Battle Monument Commission in Paris, has been assigned to duty as division engineer, North Atlantic Division, at New York.

W. A. DANIELSON, major, Quartermaster Corps, has been assigned to duty as construction quartermaster at Baltimore, Md., to direct construction of hospitals and quarters at Forts Meads, Howard, Hoyle and at Edgewood Arsenal and Camp Holabird. Previously, Major Danielson was at Governors Island, N. Y.

JESSE F. TARPLEY, JR., associate engineer, U. S. District Engineer Office, Louisville, Ky., since May, 1924, has been promoted and transferred to Washington to the specifications and plans branch of the Rivers and Harbors Board. Mr. Tarpley is a graduate of West Point but left the army after the World War. Later he re-entered the government service as a civilian engineer.

Obituary

HENRY BREHM, retired contractor of Cincinnati, Ohio, died there on Oct. 3, age 79 years. Mr. Brehm was a native of Cincinnati and began work as a contractor with his father.

ERNEST L. COLSTON, contractor of Louisville, Ky., died there on Oct. 11, age 75 years. During the past 18 years Mr. Colston has served on the Board of Public Works.

HENRY D. GORDON, formerly consulting engineer to the Jenkins Valve & Rubber Co., died at his home in East Orange, N. J., on Oct. 14, age 84 years.

WENSEL MORAVA, consulting engineer and president of the Morava Construction Company until 1924, died Oct. 13 in Chicago. He was born in Bohemia 79 years ago but came to this country early in life and obtained his engineering education at the University of Illinois.

Brief News

PORT DEVELOPMENTS planned for Detroit, Mich., to cost between $30,000,000 and $50,000,000 were definitely shelved recently when the board of supervisors of Wayne County voted to have a committee of the supervisors report on the project next April.

A NEW STANDING COMMITTEE of the American Society for Testing Materials has been organized. It is designated as Committee E-2 on Spectrographic Analysis. H. V. Churchill, chief chemist, Aluminum Co. of America, has been appointed chairman of the committee.

PUBLIC WORKS DEPARTMENT EMPLOYEES in St. John, N. B., have been placed on a three-day work per week basis because of shortage of funds. This is the first time that employees of the department have been put on a part-time basis. Heretofore the men have been laid off when funds for their employment were not available.

REPEAL OF THE WAGE LAW in California is asked in a resolution recently adopted by the California State Builders' Exchange. The resolution stated that private work is put at a disadvantage by the tendency to maintain the wage scale paid on public works higher than that paid on private work.

A SIX-HOUR DAY and a five-day week and a minimum wage of 50 cents an hour have been set up as requirements in the contract for work on the addition to the national headquarters of the Trades and Labour Congress of Canada in Ottawa. This is reported to be the first contract to be let in Canada on this basis.

CLEARING OF LANDING FIELDS and levelling them off to make them serviceable is to be undertaken by the Department of National Defense in Canada as a means of unemployment relief. It is expected that the work will provide employment for about 4,000 men. Repairs and renovation of the historic citadels at Quebec and Halifax also is to be undertaken.

A LONG DISPUTE OVER WAGE RATES paid skilled labor on the U. S. Veterans Hospital at Batavia, N. Y., was ended at a conference in Washington recently when it was agreed that carpenters would be paid 80 cents an hour, bricklayers $1.25 and common laborers 40 cents. Wages for plumbers and electricians have not been set but no controversy over them is expected.

CONSTRUCTION OF HIGHWAYS in Oklahoma accounts for 39.3 per cent or $12,394,000 of the total tax receipts of the state, according to a chart of state tax expenditures for the year ended June 30, 1932, prepared by the state auditor. This is by far the largest item on the chart, educational with 26.6 being second.

Contracts and Capital

CONSTRUCTION

(Thousands of Dollars)

	Weekly Average Oct., 1931	Oct., 1932	Week Oct. 20, 1932
Federal government	$ 4,705	$5,375	$9,574
State and municipal	21,823	14,353	18,172
Total public	$26,528	$19,728	$27,746
Total private	29,765	5,761	6,699
Week's total	$56,293	$25,489	$34,445
Cumulative, Jan. 1 to date:			
1931 construction			$2,133,993
1932			991,159

Decrease, 53 per cent.

NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

	Weekly Average Oct. 1931	Oct. 1932	Week Oct. 15 1932
R.F.C. loans		$35,700	$3,000
New capital issues	$6,200	13,200	15,100
Total	$6,200	$48,900	$18,100
Cumulative, Jan. 1 to date:			
1931 new capital			$1,913,200
1932 R.F.C. loans		$124,500	
1932 new capital		702,700	
1932 total			$827,200

Decrease, 58 per cent.

ENR Cost and Volume Index

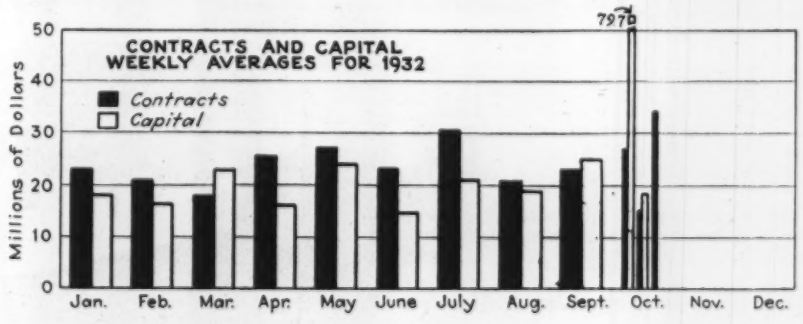
Cost		Volume	
October, 1932	159.16	Sept., 1932	124
September, 1932	157.96	August, 1932	111
October, 1931	169.78	Sept., 1931	225
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.85	1930 (Average)	260
1913 Average	100.00		

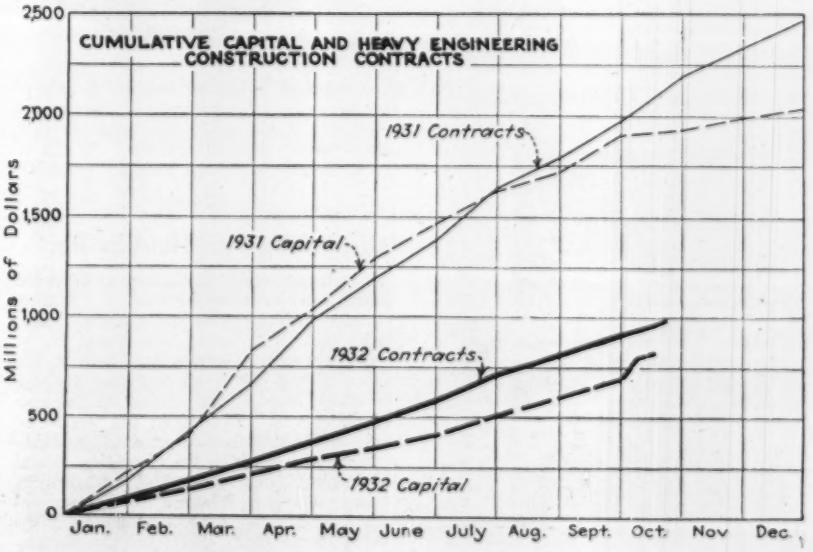
Engineering Contracts and Capital

HEAVY ENGINEERING construction contracts reported the past week total $34,445,000, one of the highest weekly figures of the year. Both federal awards, $9,574,000, and private contracts, $6,669,000, were way above the usual weekly total for these classes. Highway lettings amounted to $13,769,000, which approaches the record 15 million dollar weeks in highway awards reported last month. Missouri River levee work raised the earthwork contracts to 8 millions, the highest weekly figure in this class since July. Large highway lettings reported include Illinois, $4,579,000; Georgia, $1,598,000 and New York, $1,285,000. The largest railroad construction contract let in many months was represented by the 42-mile Dotsero cutoff of the D. & R. G. W. R.R. in Colorado, to cost $3,500,000. Other large contracts reported include Missouri River levees, $3,301,000; a public market in Portland, Ore., $1,500,000; and Mississippi River revetments, $1,200,000.

Bids have been called for on several large projects. These include dredging Lake Okeechobee, Florida, 2 millions; a customs house at Philadelphia, 4 millions; and roads in Texas, 5 millions. An agricultural pavilion is planned at San Francisco to cost $1,300,000. Low bids have been received for a court house at Jacksonville, Fla., $1,212,000; and Lock and Dam 2 and Lock 3, Ohio River, Pittsburgh, $1,190,000 and $512,000, respectively.

New capital figures as shown in the accompanying table and chart have been revised to include all self-liquidating loans approved by the Reconstruction Finance Corporation, which have amounted to $124,500,000 to date. For the past week private capital issues totaled $13,200,000; public, $1,900,000, the lowest of the year; and R.F.C. loans, $2,979,000.

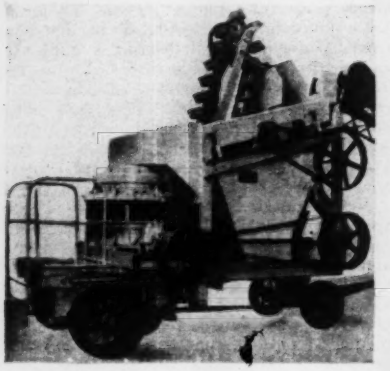




Construction Equipment and Materials

Portable Road Material Plant

A portable crushing-screening-loading plant designed to meet the trend in highway specifications calling for finer rock is announced by the Smith Engineering Works, Milwaukee, Wis. The machine is equipped with a vibrating screen instead of the shaker screen ordinarily used in portable units. The new Telsmith machine may be furnished interchangeably with a No. 24 cone crusher or a Telsmith, Wheeling jaw crusher in any one of four sizes.



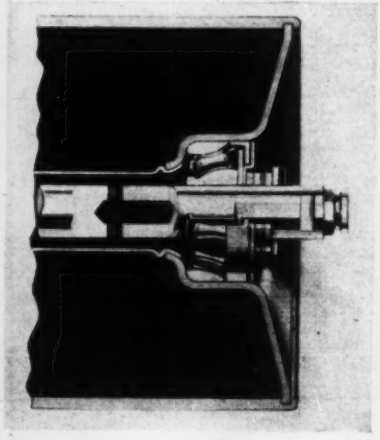
New portable machine for crushing, screening and loading road materials

All standard Telsmith portable units are equipped with self-contained plate feeder 16 in. by 5 ft., an all-steel roller bearing vibrator vibrating screen, two Telsmith conveyors, a 42 ft. feed conveyor, a 50 ft. finished product conveyor, and either 10 or 20 cu.yd. portable steel bin. Metal wheels are standard equipment but rubber tired wheels are available where desired.

Low-Friction Conveyor Rollers

The Barber-Greene Co., Aurora, Ill., has announced a new anti-friction conveyor carrier. The roller bearings are self-aligning and take thrust as well as radial load. Each size of carrier has but one size roller unit which makes these units and component parts interchangeable. The roller is made of 5½-in.-diameter seamless tubing. The ends are made of pressed steel with the outer roller face inserted under pressure. The inner tube is 1⅛ in. in dia. with two shoulders, one at each end. The spindle is of ¾-in.-diameter cold-rolled steel. The bearings are held in place by two labyrinth seal washers, shimmed so as to keep the bearings tight. Each roller could carry a load of 200 lb., or the entire carrier a load of 600 pounds.

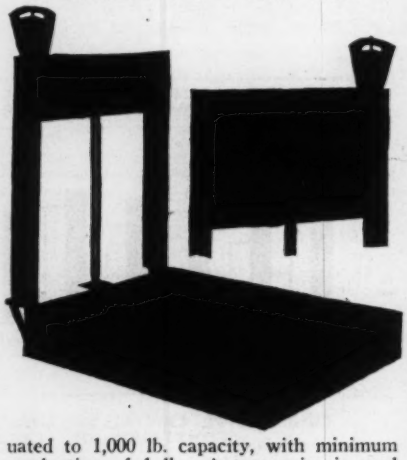
Barber-Greene's new conveyor roller



Scale for Bulk Cement

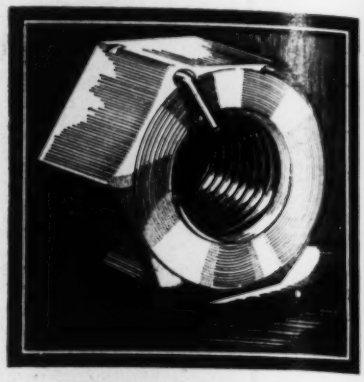
A scale for weighing bulk cement, designed to weigh loads up to 1,000 lb. accurately, has been introduced by the Winslow Government Standard Scale Works, Inc., Terre Haute, Ind. It is an all-steel scale of pipe-lever-type construction with rigid channel supports. A springless over-and-under dial is provided. The weighing mechanism consists of a single beam, graduated to 1,000 lb. capacity, with minimum graduation of 1 lb. A tare poise is used for balancing the weight of the empty wheelbarrow or cart. The scale is protected against dust or moisture. It can be set flush with platform level or runways.

New bulk-cement scale made by Winslow Government Standard Scale Works



Self-Locking Nut Held by Pin

A lock nut which is claimed to be proof against working loose because of vibration has been introduced by the General Automatic Lock Nut Corp., New York, N. Y. Fitting through a longitudinal hole at one corner of the nut is an L-shaped locking pin which engages the thread of the bolt and follows it. This turns the pin at an angle and establishes a point of impingement against the bolt, the pin biting in and maintaining this point of adjustment against vibration. The nut can be removed with a wrench by exerting sufficient pressure to momentarily throw the pin, thereby releasing the point of impingement and permitting the pin to pass over the bolt and to engage and follow the thread in the opposite direction. The manufacturer states that the nuts may be put on and taken off repeatedly without damage to either pin, threads, nuts or bolt.



The nut is prevented from working loose by the pin that engages the thread of the bolt

Equipment in Brief

Welding Blowpipe. The Linde Air Products Co., New York, N. Y., has announced a new welding blowpipe, designated as the Oxweld type W-22. The new blowpipe has been developed primarily for use on pipe line work, but the manufacturer states that its application is not restricted to this field. The oxygen and acetylene valves are located at the front of the handle, so that flame adjustment may be more readily made by the operator while the blowpipe is in operation. The acetylene valve is located on the left side where the operator's right thumb can conveniently regulate it. The oxygen valve is located on the underside of the handle. A long acetylene passageway between the acetylene valve and the injector minimizes the possibility of a flashback.

Welder. New 300- and 400-amp. gas-engine-driven Flex Arc welders have recently been announced by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. These new welders embody the following features: full canopy protection from weather, accessible control, dependable power and transformer-type reactance to prevent current surges and electrode sticking. Standard units are equipped with 6-in. rim steel-tired wheels.

Centrifugal Pump. A new line of pumping units comprising a centrifugal pump with built-in electric motor is announced by the Ingersoll-Rand Co., Phillipsburg, N. J. The pumps vary in capacity from 5 to 800 gal. per min., in heads up to 100 ft. and the motors have a capacity from 1 to 25 hp. A General Electric Co. motor is used. The unit is shipped completely assembled.

Self-Priming Pump. The Domestic Engine & Pump Co., Shippensburg, Pa., announces a new 2-in. self-priming pump of the recirculating centrifugal type. The pump is driven by a 2-hp. air-cooled engine and has a capacity of 3,000 gal. per hour at a 50 ft. head, increasing to 10,000 gal. per hour when the head is 10 ft. The pump is mounted on a two-wheel hand truck and the total weight is 410 lb.